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Sixty Years of Progress In Sanitation 1890-1950

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View at lowtide, Beacon Street, Boston, 1894

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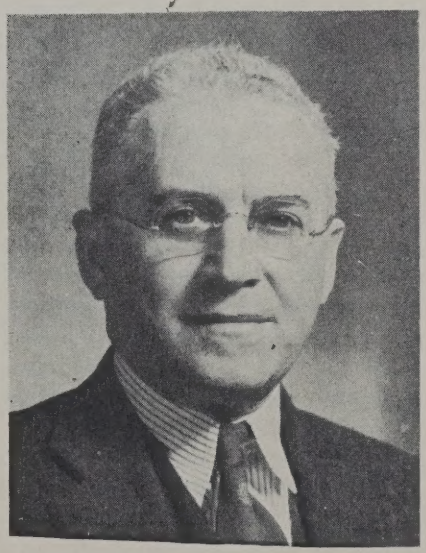
IN THIS era of great scientific discovery and technological progress, it is sometimes difficult for us to evaluate correctly the significant changes that have affected our lives even in as short a period of time as the past 60 years. The occurrence of a noteworthy anniversary* causes one to review the span of a single lifetime and to appraise some of the changes that have occurred and their significance.

The past sixty years have been noteworthy for many achievements of paramount importance. From the standpoint of time, the world has been closely knit together by the internal combustion engine, the telephone, the telegraph and the radio. Physically all the 2.5 billion humans who live on this earth are neighbors and hence are part of one world. While spiritual unity has not yet been attained, the physical unity which must precede it, is already here. Its significance to the interests and problems of professional public health workers is too evident to require further elaboration.

The past 60 years have also been tremendously significant in the development of new forms of energy, especially electricity. During the past eight years, man has learned how to



release the energy locked up in the nucleus of the atom and it is probable that this tremendous source of new energy will be utilized directly and indirectly in numerous peacetime pursuits to make life easier, more comfortable and more secure. Certainly the tremendous increase in the use of electrical energy for heating, lighting and innumerable mechanical purposes has transformed the lives of men and made them more comfortable and secure. It has taken drudgery out of labor, transformed summer into winter and vice versa, protected our food supplies, provided light where there was darkness, carried the human voice and its message to all parts of the world and performed miracles that are well known and too numerous to mention. The mere conquest of darkness must have had a profound effect on man's mental outlook and banished groundless fears and superstitions that seemed so real before.

The past sixty years have also witnessed tremendous improvements in agriculture and an earth that seemed extremely limited in its capacity to support human life with food has increased its productivity enormously so that shortages in food supply on a world scale are not imminent any longer. Foods in adequate amounts and rich in variety have banished famines in civilized areas and contributed to good health and greater longevity.

The past sixty years have also witnessed two world-wide struggles to preserve human freedoms and that unfettered way of life, free from regimentation, which is so essential for the peace of mind and happiness of the western world. Fortunately these freedoms have been preserved although not without some sacrifices. All the gains of the preceding centuries would have lost much of their value and significance if man had lost his spiritual freedoms. In fact these gains might well have been used in a totalitarian state to enslave him.

* The substance of this paper was presented at the sixtieth anniversary meeting of the Massachusetts Public Health Association held in Boston on April 25, 1950.

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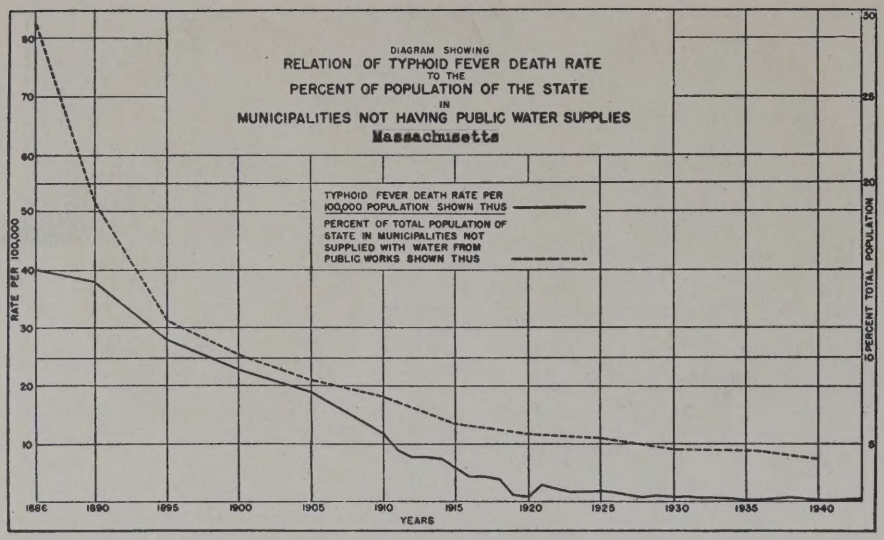


Chart showing typhoid incidence in Massachusetts, 1886 to 1940

The miracle of public health progress.—But of all the miracles achieved through science and technology during the past sixty years, none is more meaningful or majestic than the public health gains that have occurred during that period. The outstanding miracle of all has been the miracle of the prolongation of life. Life has been made longer, more comfortable, more secure. Without life all the beauties of the world may bloom unseen and unsung. With life, the unity of families has been prolonged and the grief and deprivation that attended premature death have been replaced by comradship, effort and achievement. Our fathers and grandfathers looked upon disease in fear and ignorance. Disease was due to a visitation of the wrath of God for evils real or imaginary. Through science we have learned that disease is a biological derangement due to microorganisms, or lack of minerals and vitamins, or poisons of various kinds or due to other effects of abnormal physiology. With this knowledge have come methods of prevention and control and a new profession, the profession of public health has evolved.

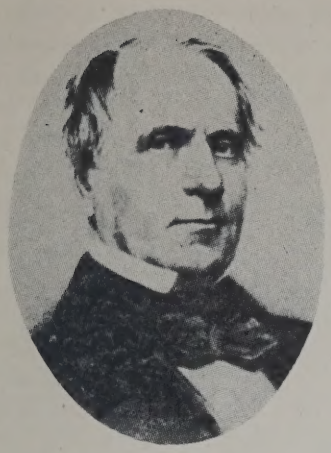
The Field of Sanitation

WHILE IT is tempting to explore the whole field of public health and its wonderful contributions to human health and welfare, this review is limited to an evaluation of the contributions made in the field of environmental sanitation. Sanitation may be defined as the science and art of conserving and promoting the public health through the control of the environment. It has for its object the promotion of the health, comfort and convenience of communities. It deals with those health problems that are common to groups or communities such as water supplies, sewerage and drainage, excreta and sewage disposal, refuse collection and disposal, milk supplies, food supplies, restaurant and food store sanitation, ice supplies, the atmosphere in relation to health and comfort, air conditioning, lighting, school sanitation, factory sanitation, housing, camp sanitation, roadside sanitation, sanitation of swimming pools, and bathing beaches, sanitary drinking facilities, street cleaning, parks and playgrounds, sanitation of public buildings, recreation places and other large places of assembly, and finally the control of those insects, rodents, vermin, odors, noises, obnoxious gases, smokes and other nuisances that are dangerous to health and comfort.

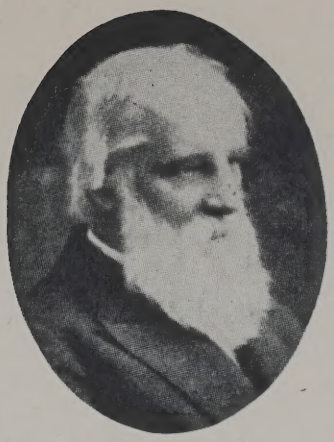
Man's environment in 1890.—It is not too difficult to visualize the insanitary conditions that prevailed pretty generally in American communities around 1890. Anyone in the seventh decade of life today will have vivid memories of the lack of sanitary facilities during the days of his childhood. The absence of running water in the home in most instances and the lack of running hot water made personal hygiene and satisfactory domestic sanitation difficult of achievement. Open privies or outdoor flush toilets with all their attendant nuisances and dangers to the public health were more common than indoor sewerage facilities. Horses were abundant and stables were everywhere. In consequence, during the warmer months of the year flies abounded in great profusion. They entered the home and food shops and any exposed food was soon covered with their dejecta and microbic contaminations. Dairy farms had not yet been forced beyond the city limits, and in consequence they added to the public health problems created by the horses and their stables. Raw milk, laden with cow dung and disease organisms, was peddled from door to door, without refrigeration, in open buckets or containers and ladled out with unclean, unsterile measures. Mechanical refrigeration was unknown and refrigeration with ice was inadequate and ineffective. In consequence food supplies suffered deterioration and spoilage and even mild infections in the food were soon of tremendous public health significance because of incubation. Streets were often unpaved and hence unclean. In some communities, sewage flowed exposed in open channels through the street of congested areas. Lighting was poor and inadequate. Housing conditions in crowded areas were intolerable. Stinks prevailed generally and the level of sanitary attainment approximated the conditions found today only in primitive backward communities.

Origin of the Massachusetts Public Health Association.—It was under conditions such as these that the Massachusetts Public Health Association came into being. Conceived by Mr. James C. Coffey, Clerk and later Executive Officer of the Worcester Board of Health, the M.P.H.A. held its first regular meeting at the Revere House in Boston on March 19, 1890. It adopted a constitution and elected the following officers: President, Dr. Henry P. Walcott, Chairman of the Mass. Board of Health; First Vice-president, Dr. Samuel H. Durgin, Chairman of the Boston Board of Health; Second Vice-President, Dr. Samuel W. Abbott, Secretary, Mass. Board of Health; Secretary, Dr. Lemuel F. Woodward, Chairman of the Worcester Board of Health; Treasurer, Dr. James F. Field, Lowell Board of Health.

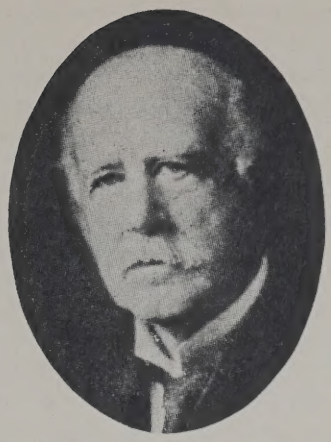
Dr. Walcott and Dr. Durgin served as President and Vice-President respectively from 1890–1913.



LEMUEL SHATTUCK



HENRY INGERSOLL BOWDITCH, M.D.



HENRY PICKERING WALCOTT, M.D.

Early Contributors

MEMBERSHIP of the Massachusetts Public Health Association over the years contained the names of many distinguished contributors to sanitation and public health. In addition to the names already mentioned among the founders of the M.P.H.A., there should be added the names of such illustrious contributors to the public health profession as William T. Sedgwick, Charles V. Chapin, Theobald Smith, C.-E. A. Winslow, Hibbert W. Hill, S. C. Prescott, M. J. Rosenau, George H. Bigelow, Francis P. Denny and many others. They were supplemented by many engineers who contributed significantly to the advancement of public health through the purification of water supplies and the treatment of sewage. Particular mention should be made of Hiram F. Mills, Frederic P. Stearns, George C. Whipple, Allen Hazen, and X. H. Goodnough. Among the bacteriologists and chemists whose names should be memorialized are Edwin O. Jordan, William Ripley Nichols, Thomas M. Drown, George W. Fuller, Ellen H. Richards, Harry W. Clark and Stephen de M. Gage.

Lemuel Shattuck and the origin of the Massachusetts State Board of Health.—In 1849, a Boston bookseller named Lemuel Shattuck was appointed by the Governor of the Commonwealth of Massachusetts as a member of a Commission of Three "to prepare and report to the next General Court, a plan for a Sanitary Survey of the State, embracing a statement of such facts and suggestions as they may think proper to illustrate the subject." In consequence, and almost entirely through his own painstaking efforts, a report was prepared and submitted in 1850 entitled "Report of a General Plan for the Promotion of Public and Personal Health." Although the report was an excellent chart and compass for the development of a modern public health organization and program, it was not until 1869 that the Massachusetts State Board of Health was organized, and became the first State Board of Health in the United States. Other states emulated this example, sooner or later, until eventually every State in the Union had a State Board of Health or a similar organization.

Some early concepts of public health.—Although the Massachusetts State Board of Health came into being before the establishment of the germ theory of disease, some of the leaders in public health during the early dawn of the modern public health movement were remarkably intelligent and farsighted. The unusual understanding and prescience of Lemuel Shattuck for the requirements of good public health practice are well known today due very largely to the resuscitation of his famous report by Professor C. -E. A. Winslow and other leaders in the American Public Health Movement and through its widespread exploitation.

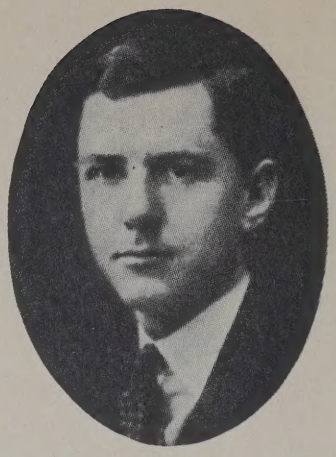
Similarly at the first meeting of the Massachusetts State Board of Health held at the State House on September 15, 1869, Dr. Henry I. Bowditch who was directed by the Governor to call the Board together stated that "the authorities of a state are bound to take care of the public health, to investigate the causes of epidemic and other diseases, in order that each citizen may not only have as long a life as nature would give him but likewise as healthy a life as possible." In the same statement, he refers to Dr. William Farr's address before the British Medical Association in 1869 in which he said that "public hygiene is a want as much as air, and public roads and waters are public necessities, and as such must be cared for and paid for by the community." "A sanitary code," Dr. Farr continues, "is needed, with proper sanitary officers; for otherwise, a code would be a dead letter."

Farr suggested that a health department should consist of four divisions—administration, medicine, engineering and statistics, while Bowditch stated that "public health has so wide a field that help is needed from all; from the chemist, the engineer, the naturalist, and from the humblest citizen as well as the highest statesmen." The value of health education was also fully appreciated, for at the first meeting of the Massachusetts State Board of Health Bowditch stated that "the law requires us to diffuse among our people any already established laws of public health, and also whatever we may hereafter discover on that subject. I look upon this feature of the law with deep interest, for I believe by it we may do much service to the people."

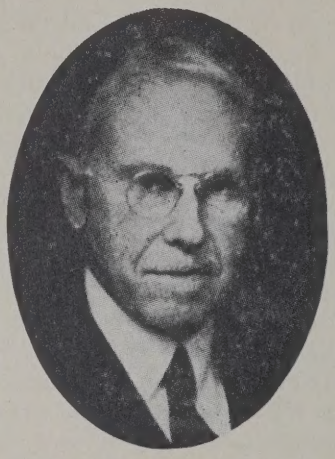
In 1874, after the State Board of Health had been in existence five years, Dr. Henry I. Bowditch, who had been Chairman during this period, prepared a statement on Preventive Medicine and the Physician of the Future which he sent to his colleagues. The letter is reprinted in the Fifth Annual Report of the State Board of Health for 1874. In it he stated that "man as an individual never stood, in the

estimation of his fellows, nor of the government, so high as he does at the present day under European or American civilization. Formerly his welfare was subordinated to that of the state. Now, the theory is exactly the reverse, and the state claims to have the tenderest interest in the welfare of each and every one, the humblest or richest of its citizens. Formerly, all persons believed, as many now believe, that prayer should be offered to the offended gods in in order to stop plagues, famine and death. But now, most persons feel that although prayer may avail much to enable the individual or a state to bear calmly some terrible calamity or to die bravely, if need be, in a great cause, it can never drive away fever, cholera nor smallpox. It can never cure consumption, though it may help sufferer and friends to bear it more patiently. To submit quietly to any remediable evil, as if to the will of Providence, is not now considered an act of piety, but an unmanly and really irreligious act. It is the part of error and stupidity which does not believe in the duty of studying into the physical causes of disease, and in at least endeavoring to crush out these originators of pestilence and of death." This seems like pretty liberal, rational thinking and in accordance with the modern scientific approach toward the solution of the ills of man even today.

Some early significant sanitary contributions from the Massachusetts State Board of Health—A review of the annual reports of the Massachusetts State Board of Health since its organization in 1869 indicates quite clearly that men of intelligence, vision and understanding were playing a vital role as immortal pioneers in the evolving field of public health. Mention has been made already of Dr. Henry I. Bowditch, first chairman of the State Board of Health, and of Lemuel Shattuck, who served as the American counterpart to Sir Edwin Chadwick of Great Britian. In the ninth annual report of the State Board of Health for 1878, long before the scientific demonstration of the relationship of drinking water to disease, we find Professor William Ripley Nichols of M. I. T. discussing the filtration of potable water in a scholarly and scientific manner.



GEORGE H. BIGELOW, M.D.



HENRY D. CHADWICK, M.D.

While he did not fully appreciate the bacterial improvement which slow sand filtration could effect, he was of the opinion that "under the management of a person of intelligence, education and experience, the simple sand filter is capable of producing sensible improvement in respect to the organic matter which is dissolved in the water." He also realized that the presence of decaying algae in a potable water gave rise to objectionable tastes and odors and that sunlight and "a certain degree of temperature" were necessary for the normal growth of these algae.

In 1879, the State Board of Health became known as the State Board of Health, Lunacy and Charity and the Supplement to the first annual report of this Board contained an illustrated article by Dr. W. G. Farlow On Some Impurities of Drinking Water Caused by Vegetable Growths. This was probably the first paper published in the United States which discussed scientifically the character of the microorganisms in drinking water which produce objectionable tastes and odors, a relationship that was recognized and appreciated before the relationship of water to disease was established.

Some contributions of Professor William T. Sedgwick.—In 1881, Profesor William T. Sedgwick came to M. I. T. to organize a Department of Biology at the young school in Boston whose future was not at all secure. This man was destined to play an heroic role as a pioneer in public health as an investigator in sanitary bacteriology, epidemiology, sanitation and public health, and as a teacher and mentor of numerous brilliant students whose outstanding achievements have promoted the public health of the United States and of other areas of the world to an astonishing degree.

He was a courageous and effective champion of the public health. He fought for clean and safe water, for clean and pasteurized milk, for clean and safe food, for the proper disposal of sewage and excreta, for a clean, wholesome atmosphere, for health education and for sound personal hygiene based on the laws of physiology. He was one of the very earliest teachers to recognize the value of bacteriology as a scientific tool for promoting the public health, and he introduced a course in this subject at M. I. T. as early as 1882.

In 1884, he and Professor William Ripley Nichols published a report in the Supplement to the Sixth Annual Report of the State Board of Health, Lunacy and Charity entitled A Study of the Relative Poisonous Effects of Coal and Water Gas. In this paper they showed that water gas was more toxic than coal gas and told of experiments with dogs, cats and rabbits to substantiate their conclusions. This was an early date to be expounding the hazards of carbon monoxide poisoning.

Dr. Henry P. Walcott.—Another great figure in the early history of public health in Massachusetts and hence in the United States was Dr. Henry P. Walcott. He was Chairman of the State Board of Health from its reorganization in 1886 until 1914 when it was again reorganized, this time as a State Department of Public Health with a Public Health Council. He was also Chairman of the Metro-

politan Water and Sewerage Board; Chairman of the Massachusetts General Hospital; Member of the Corporation of Harvard University and twice its acting President; President of the American Public Health Association in 1902; and President of the International Congress on Hygiene and Demography which met in Washington in 1912. It is reported that he was a very distinguished looking man and that he presided with graciousness and dignity.

Legislative Report of 1886 on Drainage.—In 1886, a State Legislative document appeared entitled Report of a Commission to Consider a General System of Drainage for the Valleys of the Mystic, Blackstone and Charles Rivers. It is said that this report was prepared very largely by Dr. Wolcott. It is generally agreed that it laid the foundation for the work of the State Board of Health in connection with the Purity of Inland Waters. Professor George C. Whipple stated in 1917 that "its forceful and eloquent words have been the inspiration of Massachusetts engineers for more than thirty years and should continue to give inspiration for all time to come."

After commenting on the steady degradation of the streams in Massachusetts with sewage and industrial wastes, the report stated that "The growth of population, the spread of modern refinements of living, the increase in industrial establishments, and all the indefinite multiplication of incidents appertaining to a prosperous and progressive community must naturally and perhaps inevitably tend to vitiate the water of its rivers and lakes. But even if a certain degree of taint be unavoidable, there is a vast amount which is wanton and preventable. A cursory glance at the report of Mr. Eliot C. Clarke will convince anyone that there is no necessity whatever for a large part of the abuse to which our water courses are subjected. It is a question of time only, and that not a long time either, when, if we hold to the path we are traveling, we shall find ourselves face to face with a state of things as intolerable as that of England twenty-five years ago, when the Sewage of Towns Commission denounced it as an "evil of national urgency requiring the earliest and most serious attention." We think it high time that some steps should be taken here to arrest the progress of rivers pollution at the point it has reached today in Massachusetts, and gradually to retrieve some portion, at least, of the ground we have carelessly yielded." These words are timely and appropriate even for the present time and it was not until 1948 that Congress adopted a national stream-pollution control act. This work is only just getting under way, and as a nation we are just beginning to realize that the conservation and protection of our water resources represent one of the major problems affecting the national welfare.

In concluding the Legislative report, Dr. Walcott stated, "We think it would be well for the Legislature to designate some one or more persons to look after the public interests in this direction. Let these guardians of inland waters be charged to acquaint themselves with the actual condition of all waters within the state as respects their pollution or purity, and to inform themselves particularly as to the relation which that condition bears to the health and well-being of any part of the people of the Commonwealth. Let them do away, as far as possible, with all remediable pollution and use every means in their power to prevent further vitiation. Let them make it their business to advise and assist cities or towns desiring a supply of water or a system of sewerage. They shall put themselves at the disposal of manufacturers and others using rivers, streams or ponds, or in any way misusing them, to suggest the best means of minimizing the amount of dirt in their effluent and to experiment upon methods of reducing or avoiding pollution. They shall warn the persistent violator of all reasonable regulation in the management of water of the consequences of his acts. In a word, it shall be their especial function to guard the public interest and the public health in its relation with water, whether pure or defiled, with the ultimate hope, which must never be abandoned, that sooner or later ways may be found to redeem and preserve all the waters of the state."

PART TWO

NOVEMBER 1951

IN 1888, Greenleaf R. Tucker working with Professor Sedgwick studied the microorganisms in the air of the Boston City Hospital qualitatively and quantitatively. His excellent paper was published in the annual report of the Massachusetts State Board of Health for that year. The methods of collecting samples of air were quite ingenious and satisfactory and Koch's solid culture medium procedure for growing bacteria, developed in 1881, was employed. This work led to the development of the aerobioscope, a device for sampling and cultivating the organisms in the air in one apparatus. In the latter respect, it resembles the culturing procedure in use in the Wells air centrifuge today. At a time when the atmosphere was regarded as a very significant vehicle of disease, Tucker's findings indicated that the microbial content of the air in the Boston City Hospital was remarkably low.

Early studies on the sanitary quality of natural ice. In 1888, the Massachusetts General Court instructed the State Board of Health to "make a special investigation with reference to the pollution of ponds, lakes, streams or other bodies of water used as ice supplies in this State, especially with reference to the effect of such pollution upon the healthfulness of such ice for domestic use." Dr. Prudden in New York had already shown that the typhoid bacillus would live in ice for at least three months and since most of the ice in use was natural ice and some of it was harvested from polluted ponds and streams, the possibility of contracting typhoid fever from water or food infected from such ice was regarded as very real. In consequence, natural ice from numerous sources was examined chemically and bacteriologically and the results obtained were published in the annual report of the State Board of Health for 1889. The relative freedom of pollution in clear ice even from polluted sources was definitely established while the potential hazards of snow ice and ice formed by flooding were also emphasized.

Disposal of sewage from Mystic and Charles River Valleys. The State Board of Health also made a special report in 1889 on the problem relating to sewage disposal in the Mystic and Charles River Valleys and recommended that "the only reasonable practical method of disposing of the sewage of the North Metropolitan Sewerage System was to dis-

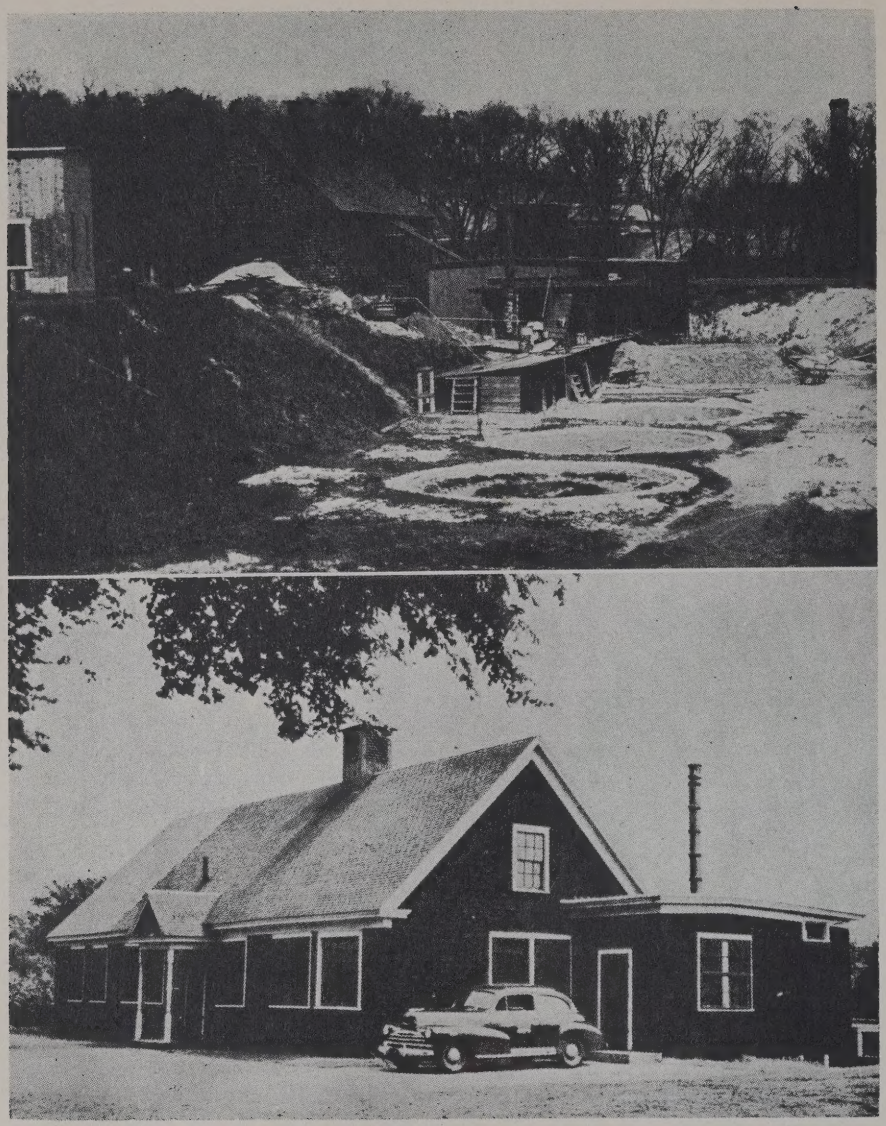


Photo courtesy Massachusetts State Health Dept.

Upper—Early view of the Lawrence Experimental Station
Lower—Present Station which has complete laboratories.

charge the crude sewage into the sea" through the outlet near the Deer Island Beacon. This method of disposal has continued to the present day and will doubtless have to be modified and improved.

Early consideration of sanitary quality of water supplies. The Twenty Second Annual Report of the State Board of Health published in 1890 is rich in contributions of great sanitary interest and significance. Mr. Frederic P. Stearns published a paper on the Selection of Sources of Water Supply and emphasized the importance of selecting potable supplies that are free from pollution, that are free from tastes and odors and that are relatively soft. In another paper, Hiram F. Mills discussed Typhoid Fever in Its Relation to Water Supplies with particular reference to the high death rates from typhoid fever in Lowell and Lawrence compared with those of Boston. This is a fine example of epidemiological research and pointed to the danger of drinking untreated river water that had been polluted with sewage further upstream.

The same report contains an excellent study of the normal chloride map of Massachusetts and another paper by Frederic P. Stearns and Dr. Thomas M. Drown on The Effect of Storage Upon the Taste and Odor of Surface Waters. The latter recommended that artificial storage reservoirs should have the vegetable matter removed from its bottom and sides during construction in order to diminish the probability of developing tastes and odors in the stored water due to the growth of algae and other taste-producing microorganisms. In the same report, Frederic P. Stearns discussed The Pollution of Streams and emphasizes the value of dilution in stream purification.

Lawrence Experiment Station

ALONG with the reorganization of the State Board of Health in 1886, the Legislature passed an Act entitled "An Act to Protect the Purity of Inland Waters." This led to the establishment of an Engineering Division in the State Board of Health and to the Lawrence Experiment Station which was to become internationally famous in sanitary history. Hiram F. Mills became the consulting engineer; Dr. Thomas M. Drown, the consulting chemist; and Professor William T. Sedgwick, the consulting biologist. Here were brought together the combined disciplines represented by these consultants on the problems associated with water and sewage. More important still, the Experiment Station was staffed in time by a group of brilliant young investigators who made notable contributions to the science and art of sewage purification. Here were worked out some of the fundamental principles underlying the biological methods of sewage treatment, which represent the most modern and satisfactory methods of sewage treatment even today. The ten years following the establishment of the Lawrence Experiment Station are often referred to as the Golden Decade in Sanitation. Nearly all of the young men associated with the Experiment Station during this period became international figures in Sanitary Science. Among them were Allen Hazen, the engineer; George W. Fuller, the chemist; Edwin O. Jordan, the bacteriologist; and Gary N. Calkins, the biologist and protozoologist. All were students under Professor Sedgwick at M.I.T.

Early reports on sewage treatment by filtration. Another important paper in the anual report of the State Board of Health for 1890 was prepared by Hiram F. Mills and dealt with The Filtration of Sewage, A General View of Results of Experiments at the Lawrence Experiment Station. Professor Whipple states that "the scientific deductions from the work done at Lawrence during these early years profoundly affected engineering practice." The report is a classic which should be studied by all students of sanitary engineering. Mr. Mills recognized the biological character of the purification effected by intermittent sand filtration, the importance of nitrification in producing a stable effluent, the value of

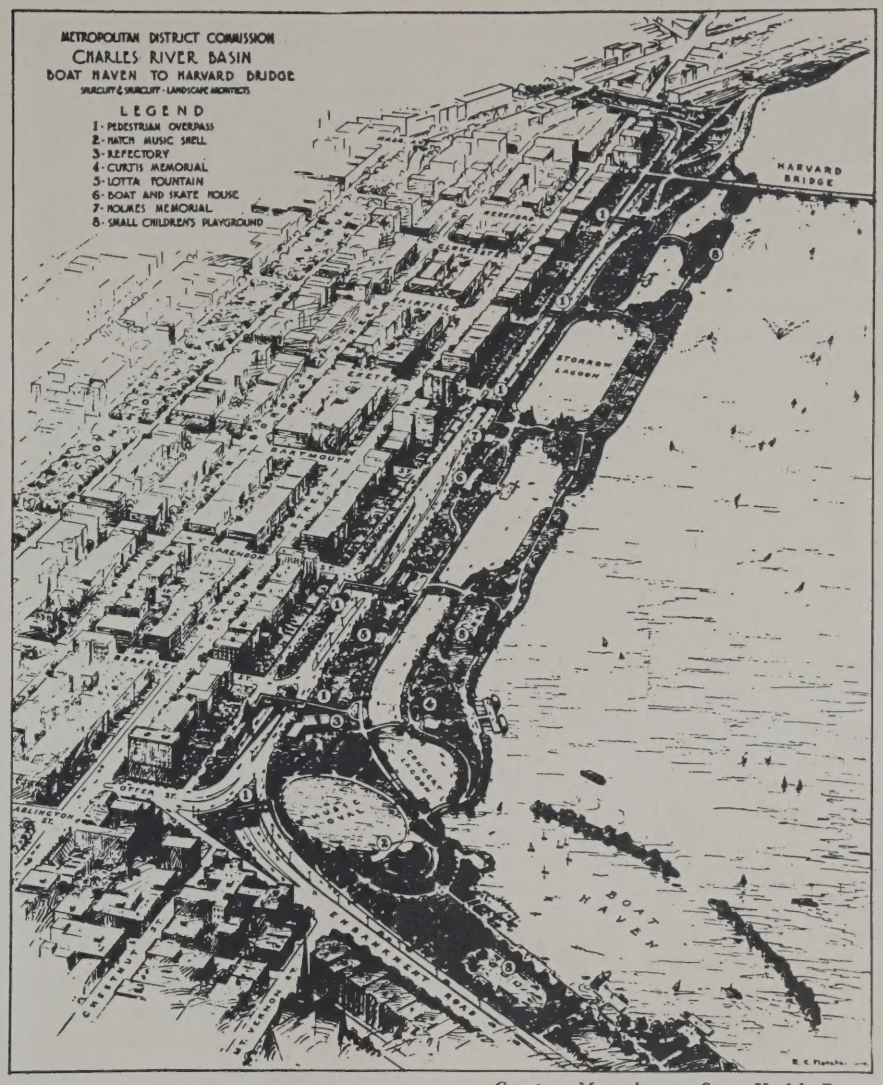
aerobic conditions and the remarkable improvement in bacterial content as well as the physical characteristics of the treated sewage. He concluded that "the sewage effluents from intermittent sand filters can be turned into a drinking water stream, where they will be much diluted, without risk of injury to those who drink from it."

Reports by Hazen, Sedgwick, Jordan and Richards. The 1890 report likewise contained a paper by Allen Hazen on The Chemical Precipitation of Sewage and one by William T. Sedgwick on Microscopical Analysis of drinking waters which dealt with the development of the Sedgwick-Rafter method which is still currently employed in the examination of water supplies for taste-producing organisms. Another paper by Edwin O. Jordan and Ellen H. Richards was entitled Investigations Upon Nitrification and the Nitrifying Organism and dealt with some of the earliest work that led to an understanding of the process of nitrification. Winogradsky, the Russian microbiologist, was demonstrating simultaneously and independently the role of the nitrifying organisms in the production of nitrites and nitrates from simple ammonical compounds. Normally credit for these important discoveries is assigned to him. It should be remembered, however, that Jordan and Richards were making similar observations in 1890 at the Lawrence Experiment Station and that they too realized there were numerous organisms playing a fundamental role in nature that could not be cultivated on the complex peptone gelatin media in use in the bacteriology laboratory at that time.

Effective size and uniformity coefficient. Several very important papers appeared in the annual report of the State Board of Health for 1892. Among these, special mention should be made of Dr. Drown's paper entitled The Interpretation of Water Analyses and Hazen's paper on Some Physical Properties of Sands and Gravels, with Special Reference to Their Use in Filtration. Both papers are regarded as classics. In addition, Hazen's paper introduces the concepts of Effective Size and Uniformity Coefficient, two terms which have proved to be invaluable in prescribing the proper size of sand for use in water and sewage filtration.

Sedgwick's studies on typhoid fever in Merrimac River Valley. In the same report, Professor Sedgwick published his historic report on The Investigation of Recent Epidemics of Typhoid Fever in Massachusetts. This report dealt with the unusual prevalence of typhoid fever in the Merrimac River Valley between 1888 and 1893, with particular emphasis on the Lowell and Lawrence epidemics of 1890–1891. This report served to focus attention on the fact that typhoid fever at that time was frequently a water-borne disease.

It led directly to the construction of a slow sand filter plant for the water supply of the City of Lawrence and for years these filters stood between the disease and death that abounded in the sewage polluted waters of the Merrimac River and the continued health and survival of the residents of that city. To have discovered that the passage of sewage polluted infected river water through 4 or 5 feet of sand would deprive that water supply of its disease and death-dealing properties should be ranked with the great scientific developments of all time. Unquestionably, Sedgwick's epidemiological investigations on water-borne typhoid fever and the subsequent demonstration of the effectiveness of various methods of water purification ushered in an era of sanitary engineering activity which in the brief span of sixty years has witnessed the virtual elimination of water-borne typhoid fever from public water supplies in the United States.



Courtesy Massachusetts State Health Dept.

Original plan of the Metropolitan Park Commission which was initial step to beautifying and clearing Charles River.

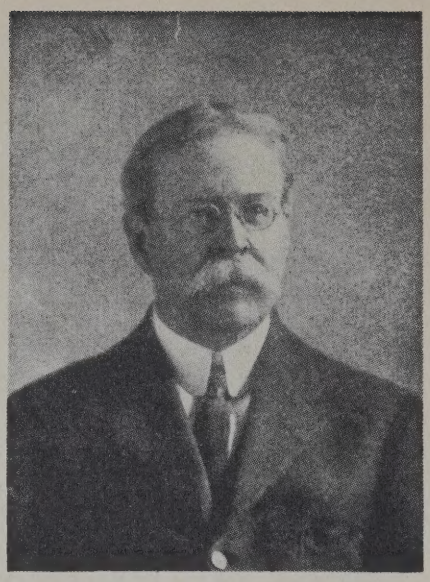
Milk-borne Typhoid Fever

IN THE SAME year, Professor Sedgwick published the results of his investigations of the milk-borne epidemics of typhoid fever in Springfield and Somerville, Mass. These were among the earliest epidemics of milk-borne typhoid fever studied anywhere and focused attention on the need for greatly improved sanitary methods in the production and handling of milk. It also pointed to the tremendous significance of pas-

teurization as a method of insuring the safety of milk. In 1890, Professor Sedgwick and John L. Batchelder, one of his students, conducted a bacterial survey of the milks sold in Boston and found without exception that the total counts were in the millions per ml. This is probably the first bacterial survey ever made of the milk supply of a municipality and directed attention to the need of giving consideration to a major public health problem.

Conditions on dairy farms in 1905. Perhaps the presence of millions of bacteria per ml. of milk may not be sufficiently impressive to the ordinary individual. It is, therefore, appropriate to quote from Dr. Charles W. Harrington's report on Inspection of Dairies which appeared in the Thirty Seventh Annual Report of the Board of Health for 1905. This brief quotation graphically describes the filthy conditions that surrounded the production of milk at the turn of the century, conditions which were unquestionably responsible for many cases of disease and many deaths. One of the most notable sanitary achievements in the United States during the past sixty years has been the sanitation of our public milk supplies. Milk has been transfomed from a food that was laden with dung, disease and death to something that is wholesome, safe and nutritious. This has been accomplished through improvements in sanitation coupled with the general acceptance of pasteurization.

Dr. Harrington's statement follows: "The majority of the herds observed were found to be kept in a condition far removed from cleanliness. In some cases an entire herd would be found to be encrusted, chiefly on the hinder parts, with wet and dry excrement. In many barns the conditions were found to be such that a cow, however clean she might be on introduction, could not fail to be dirty to an objectionable extent within 24 hours. As though the natural opportunities afforded for becoming filthy were not already ample, in no fewer than 182 cases was horse manure employed as a bedding material. Inquiry developed the fact that on most farms not only are the cows never groomed, but usually not even their udders are wiped off before the process of milking is begun." Numerous cows were tuberculous or suffered from contagious abortion while others still were afflicted with garget. Prompt and adequate refrigeration was unknown; the insanitary tasting of milk was quite common; and suitable equipment for handling milk in a sanitary manner was not even in its early stages of development.



WILLIAM T. SEDGWICK

The struggle for pasteurization and clean milk. As early as 1892, Sedgwick led a public attack on the insanitary condition of our milk supplies. In various papers, some of which were presented before the Massachusetts Public Health Association, he advocated the adoption of a milk sanitation code for boards of health in the Commonwealth. At the same time he was a staunch advocate of pasteurization as the only sure way of insuring the safety of municipal milk supplies. In this campaign he was staunchly supported by Dr. Charles V. Chapin, distinguished Health Officer of Providence, R. I., and by Dr. Theobald Smith of the Harvard Medical School. Strangely enough, some of the strongest opposition to pasteurization came from the pediatricians and in particular from Dr. T. M. Rotch, Professor of Pediatrics at the Harvard Medical School. Time however was on the side of scientific knowledge and civic wisdom.

In 1904, the Boston Board of Health adopted a regulation requiring that all milk sold in Boston must contain less than 500,000 bacteria per ml. Certified milk made its appearance in 1906, and on March 7, 1924, a regulation was adopted in Boston requiring that all milk had to be pasteurized or come from tuberculin tested cows. On September 12, 1928 this requirement was modified so that all milk had to be pasteurized or certified. On January 1, 1929, the Boston Health Department regulations were changed again and this time it was provided that certified milk could also be pasteurized. Until that time the proponents of certified milk maintained that pasteurization nullified certification. In consequence, pasteurization as an additional safeguard to certification was bitterly opposed. By making pasteurization of certified milk permissive and by tracing certain outbreaks of disease to the use of certified raw milk, a great impetus was provided for the ultimate adoption of a universal pasteurization law.

On July 31, 1941, the Boston milk regulations were modified to prohibit the sale of certified raw milk in Boston except on a physician's prescription. Finally, on October 1, 1943, the milk regulations were modified again to prohibit the sale of any raw milk, certified or non-certified, with or without a physician's prescription. At last the milk supply of a great city and an even greater metropolitan area was safe guarded against disease through universal pastuerization. Boston and Massachusetts will always be indebted to Mr. Frank E. Mott, Milk Inspector for the City of Boston, who has courageously and persistently waged an effective campaign to sanitate and safeguard the milk supply of Boston. Brookline and Newton have also had staunch advocates of pasteurization and milk sanitation but the predominant influence which Boston exerts on the Metropolitan area enhances substantially every major public health measure that is adopted there.

Conditions in Charles River

ONE OF THE sanitary sore spots in the vicinity of Boston towards the end of the nineteenth century was the Charles River. This stream was a tidal river which received a great deal of domestic and industrial pollution. When the tide was out the banks of the river and the river bed itself were exposed up to the U. S. Arsenal at Watertown and with the passage of time and the substantial increase in pollution, exceedingly offensive conditions were created. Hydrogen sulphide gas was given off during the warmer months of the year; windows of nearby resi-

dences had to be kept closed; property values in the vicinity depreciated; and numerous complaints were filed by physicians and home owners begging for relief. Finally, the Legislature appointed a Joint Board consisting of the State Board of Health and the Metropolitan Park Commissioners to study the problem and to submit a report with recommendations. This report was filed by Dr. Henry P. Walcott, Chairman, on April 27, 1894. It recommended the construction of the Charles River Dam and the development of the Charles River Basin. In consequence, work on this project was subsequently authorized and a stream that was noisome and offensive and prejudicial to the public health became transformed into something beautiful, with long stretches of public parks and spacious highways along its banks. A great liability was transformed into an invaluable public asset.

Studies on the extension of the Boston Metropolitan water supply. Metropolitan Boston was growing rapidly toward the close of the nineteenth century and the State Board of Health was exceedingly conscious of the necessity of providing an adequate, safe water supply for this great and populous area. Accordingly a study was initiated into this important problem and a report was submitted to the Legislature by the State Board of Health in 1895. Various plans for possible sources of water were studied, but it was finally decided to recommend the construction of what is now the Wachusett Reservoir and to join it with the Sudbury Reservior which was already in existence.

Subsequently the further needs of the Metropolitan Area received additional study and in consequence final authorization was obtained to construct the Quabbin Reservoir in western Massachusetts and to bring the water to Metropolitan Boston through the Coldbrook Tunnel, the Wachusett and Sudbury Reservoirs and the aqueducts that lead from the latter to the large and populous area that is served. Water is available in such amounts and in such a degree of purity that this primary requirement for life, for good sanitation and for adequate public health protection is assured most adequately for many years into the future.

Rivers and harbor pollution. By 1895, the Neponset River flowing through the area immediately south of Boston, had developed public health significance. Pollution was increasing from homes and industry, mosquito breeding places abounded and malaria was prevalent in portions of the Neponset River Valley to a serious degree. In 1895, the Legislature authorized the State Board of Health to study the situation and a report was submitted in 1897 entitled The Sanitary Condition and Improvement of the Neponset Meadows. The marshland was to be drained as a means of combating malaria in that region even though the mode of transmission of malaria had not yet been established. Provision was also made to control the pollution entering the stream.

In 1900, the State Board of Health in a special report to the Legislature recommended the construction of the South Metropolitan Sewerage System and the location of an outfall sewer in deep water at Nut Island. The pollution of Boston Harbor has been studied on various occasions since 1900 and measures have finally been taken to treat some of the enormous quantity of sewage discharged every day. This is necessary in order to protect the bathing beaches of Boston and the neighboring communities as well as the areas from which shellfish is still obtained for human use.

The Merrimac River has likewise been subjected to extensive study with the hope that eventually the sewage that is discharged into it at present will be purified to such a degree that the waters in the stream will be clean and safe. The reclamation of our rivers, lakes and tidal estuaries from the degradation of gross sewage pollution is one of the chief problems in environmental sanitation confronting the country today. It is the fervent hope of all sanitarians that this day may be hastened so that the public health may be adequately safeguarded.

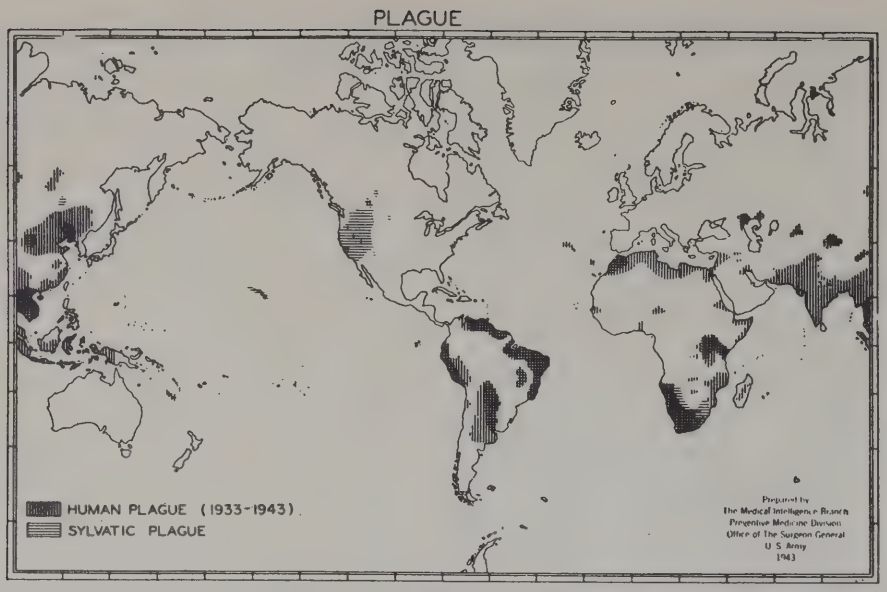
PART THREE

DECEMBER 1951

WHILE the establishment of the germ theory of disease and the relationship of infected water, milk and food to typhoid fever and other enteric diseases naturally stimulated the purification of water supplies, the construction of sewerage systems and the safeguarding of milk and food supplies, other important discoveries were being made in the relationship of the environment to disease. This was particularly true in the field of insect-borne diseases. The demonstration that certain insects are responsible for the incidence of numerous widely prevalent diseases in man and the development of effective methods of prevention and control have enabled man to remain ascendant in the struggle for survival against powerful enemies. These discoveries represent another glorious chapter in scientific research and accomplishment.

In 1893, Theobald Smith and F. L. Kilborne demonstrated that Texas Fever, a disease of cattle, is transmitted through the bite of an infected tick. While many may have postulated the possible relationship between insects and disease, this was the first scientific demonstration that an infected insect could establish disease in a healthy animal. The following 20 or 25 years were to witness the establishment of the relationship of flies, mosquitoes, fleas, lice and ticks to various diseases in man. These brilliant discoveries have lighted the way for salvation from preventable disease and premature death to millions of people throughout the world. In 1894, Yersin demonstrated that bubonic plague, the cause of the Great Black Death of the middle ages was caused by a bacillus — Pasteurella pestis. Before many years had elapsed, the British India Plague Commission had established the fact that bubonic plague was transmitted to man through the bite of the rat flea. In consequence, anti-rodent campaigns represent an important feature of the program in environmental sanitation today. The campaigns emphasize effective rat-proofing of all structures inhabited by man, the protection of food against rodent depredations at all times and the use of effective rat poisons such as warfarin, red squill, 1080 (sodium fluoroacetate), antu (alpha naphthylthiourea), and other improved rodenticides that have been discovered in recent years.

The malaria problem and its control. Malaria has been a devastating scourge of man for many centuries. It is estimated that over 300,000,000 cases of malaria occur annually in the world even today. Balfour suggests that there are 100,000,000 cases and 1,000,000 deaths from malaria



It has been proven that most human plagues have been caused by bacilli and rodents and insects.

annually in India. While no approximate estimates are available for China, it is known that malaria is unusually prevalent. Simmons reports that "malaria remains the undefeated champion of all the infections of tropical and subtropical regions." Even in some of the Southern states malaria is still an important cause of disability. However, by various methods of control, including ditching, draining, oiling, filling, the use of Paris Green and recently of DDT, as well as through the use of quinine, atabrine and other effective chemical agents against the plasmodia that cause malaria, great progress has been made against this disease in Italy, Sardinia, Cyprus, Greece, the United States and various other parts of the world where effective programs have been waged.

The world will always be indebted to Sir Ronald Ross for his epochmaking discovery that the malarial parasite spends part of its life cycle in the body of the female Anopheles mosquito. This was demonstrated in August 1897. In 1900, Sambon and Low, two British physicians, demonstrated that malaria is transmitted to man only through the bite of an infected female Anopheles mosquito. With this experimental demonstration, the way was now opened for an effective attack on this disease.

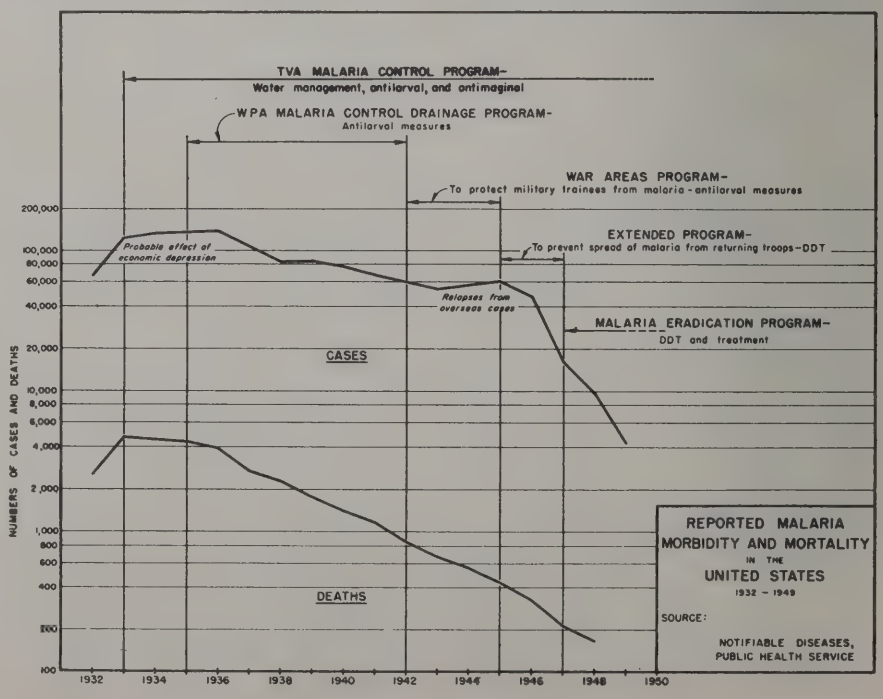
Control of Yellow Fever

ANOTHER disease that took a tremendous toll in human life during the early part of the period under discussion was yellow fever. The disease was widespread throughout the world in the tropical and subtropical regions and even affected the United States in epidemic form from time to time. New Orleans was one of the greatest sufferers from yellow fever. It served as the gateway from the tropics to the United States and the disease traveled from here up the Mississippi River Valley. New Orleans experienced an epidemic of yellow fever even as recently as 1905. The disease had also appeared in epidemic form as far North as New York in 1870. Philadelphia had a serious epidemic in 1793 and Baltimore in 1819. In 1900, yellow fever had a global distribution.

It was under these conditions that General Walter Reed and his colleagues began the study of the mode of transmission of yellow fever in Havana, Cuba, in 1900. Havana had been made spotlessly clean without affecting the unusual prevalence of yellow fever. In the light of Ronald Ross' work on malaria and the demonstration by Sambon and Low that the Anopheles mosquito was involved in the transmission of malaria, attention was directed toward the existence of a similar vehicle in the case of yellow fever. Success attended this hypothesis following a brilliant series of experiments.

Thus a new approach toward the conquest of a deadly and widespread disease resulted. In consequence, in the brief span of 50 years, yellow fever has been made to recede until today it exists largely in animal reservoirs in the jungles of Brazil and on the west coat of Africa. An efficient vaccine has also been developed against yellow fever. This was of immeasurable help in the protection of American soldiers during World War II when they had to enter areas of the world where yellow fever might be prevalent. By studying the biology and habits of the yellow fever mosquitoes, it has been possible to develop effective means of combating them. The relationship of other diseases which are conveyed by infected mosquitoes, such as dengue fever, filariasis, and equine encephalomyelitis, has also been established during the twentieth century, and effective measures to combat them have in consequence resulted. In 1938, Mas-

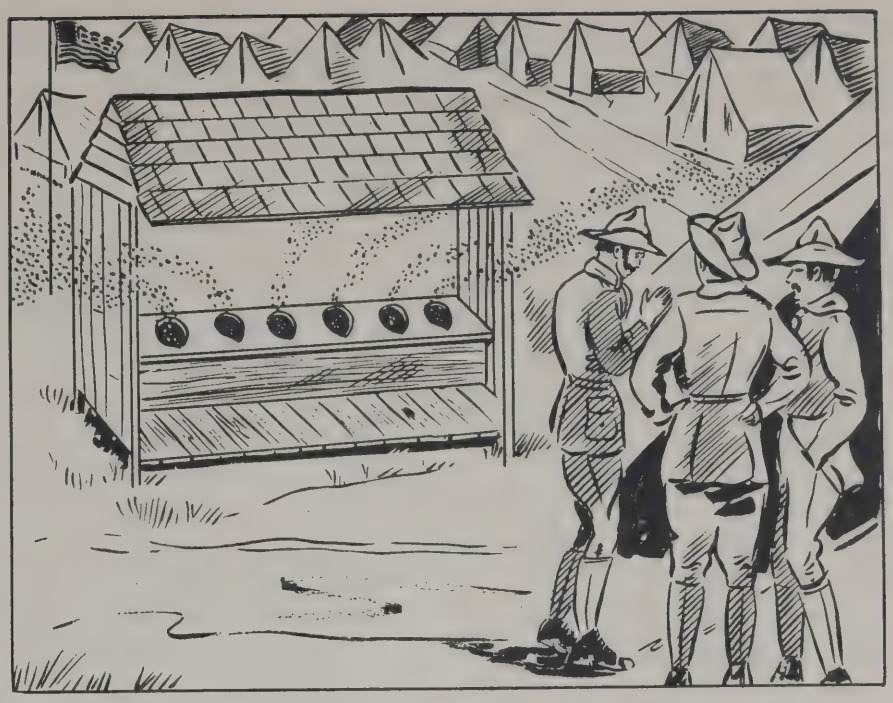
The malaria problem has engaged the talents of the medical and sanitation professions for years.



sachusetts experienced an epidemic of equine encephalomyelitis with 34 cases and 25 deaths.

Flies in relation to disease. Flies represent another group of insects which play an important role in the transmission of disease. This relationship has also been established definitely during the past sixty years. Some flies like Musca domestica, the common house fly, are merely mechanical vectors of disease germs. They are associated primarily with the enteric and pyogenic infections. Other flies, like the biting stable fly, the deer fly and the tsetse fly, are blood-sucking flies and they are capable of transmitting a great variety of serious diseases. The tsetse fly transmits the trypanosome of African sleeping sickness; Stomoxys calcitrans, the stable fly, may transmit anthrax and relapsing fever and under experimental conditions was capable of transmitting poliomyelitis to chimpanzees; and the deer fly (Chrysops) is able to transmit tularemia and filariasis.

In the United States, the house fly has doubtless been associated with disease to a greater degree than any other fly. In our Southern states, where the fly breeding season is very long, and where the sanitary disposal of human excrement in the past has not been as extensive as in the North, flies have played an important role in the transmission of enteric diseases. This important relationship was emphasized by the experience of the American armed forces during the Spanish-American War. Out of 107,973 men who were encamped in our Southern states between May and October 1898, a total of six months, 10,428 definite clinical cases of typhoid fever and 10,310 probable cases of typhoid fever developed. In other words, about one out of every five men contracted typhoid fever or some allied enteric infection during this period. Of the number who developed typhoid fever, 1,580 died. The mortality resulting from typhoid fever was greater than that resulting from battle injuries. Seven soldiers died of disease in this war for every one killed in battle. A U. S. Army Medical Commission consisting of Rede, Vaughan and Shakespeare, was appointed to study the typhoid situation among the American troops and Vaughan reported that "flies swarmed over infected fecal matter in the pits and fed upon the food prepared for the soldiers in the mess tents. In some instances where lime had recently been sprinkled over the contents of the pits, flies with their feet whitened with lime, were seen walking over the food." Vaughan stated subsequently that in his judgment 15 per cent of the cases in the camps were caused by fly transmission.



Flies pay an important role in the transmission of disease. During the Spanish-American war, seven soldiers died of disease for every one killed in battle.

Suppression of Flies

ONE OF the great sanitary achievements of the past 50 years in the United States has been the suppression of flies. Many factors have been at work to accomplish this improvement, one of the most important of which has unquestionably been the universal use of the automobile instead of the horse for transportation. The provision of sewers and sanitary methods of excreta disposal; the great reduction in stables and cow barns within urban limits; the proper storage and frequent removal of organic refuse; and the extensive use of DDT in recent years have all played a role in achieving this important sanitary improvement. While DDT resistant strains of flies may develop through the widespread use of DDT sprays, other effective chlorinated hydrocarbons are available if necessary to combat them. Furthermore, the continued elimination of numerous active fly breeding places also helps definitely to establish man's permanent ascendancy over this insect.

Automobile fatalities. While man's control of the common house fly in the United States has been accomplished to a considerable degree by substituting the automobile for the horse, the saving of human lives from disease and death which resulted has been offset by the tremendous increase in automobile fatalities. According to John Cruickshank, chief engineer of the United States Guarantee Company, 927,260 persons were killed by automobiles in the United States from 1907–1949. In 1907, the toll was 666 while in 1949, it was 31,500. A death by accident counts just as much in the vital statistics as a death from a communicable disease. In consequence, the automobile has created for public health authorities a problem of the environment which must be met, just as effectively as the control of the diseases and deaths associated with infected water, unsafe milk or food, and infected insect vectors has been met during the past 60 years. Unfortunately the control of automobile accidents is dependent in part on the control of human behavior, and that is not easy of achievement.

Lice and typhus fever. Another insect which has taken a terrific toll in human life has been the body louse. It is associated with a group of diseases produced by Rickettsia, a group of microorganisms named after the American investigator Ricketts, who succumbed to typhus fever while studying the disease in Mexico.

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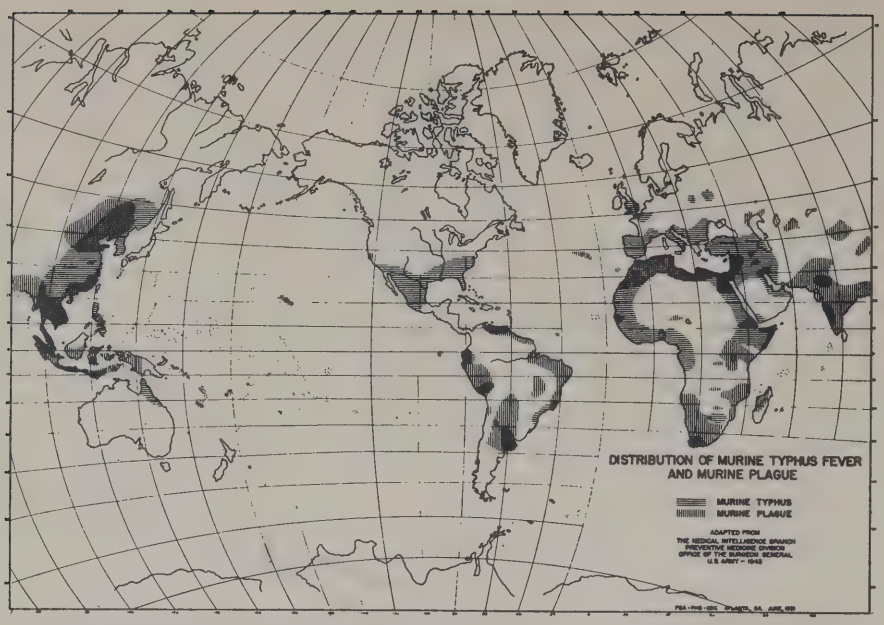
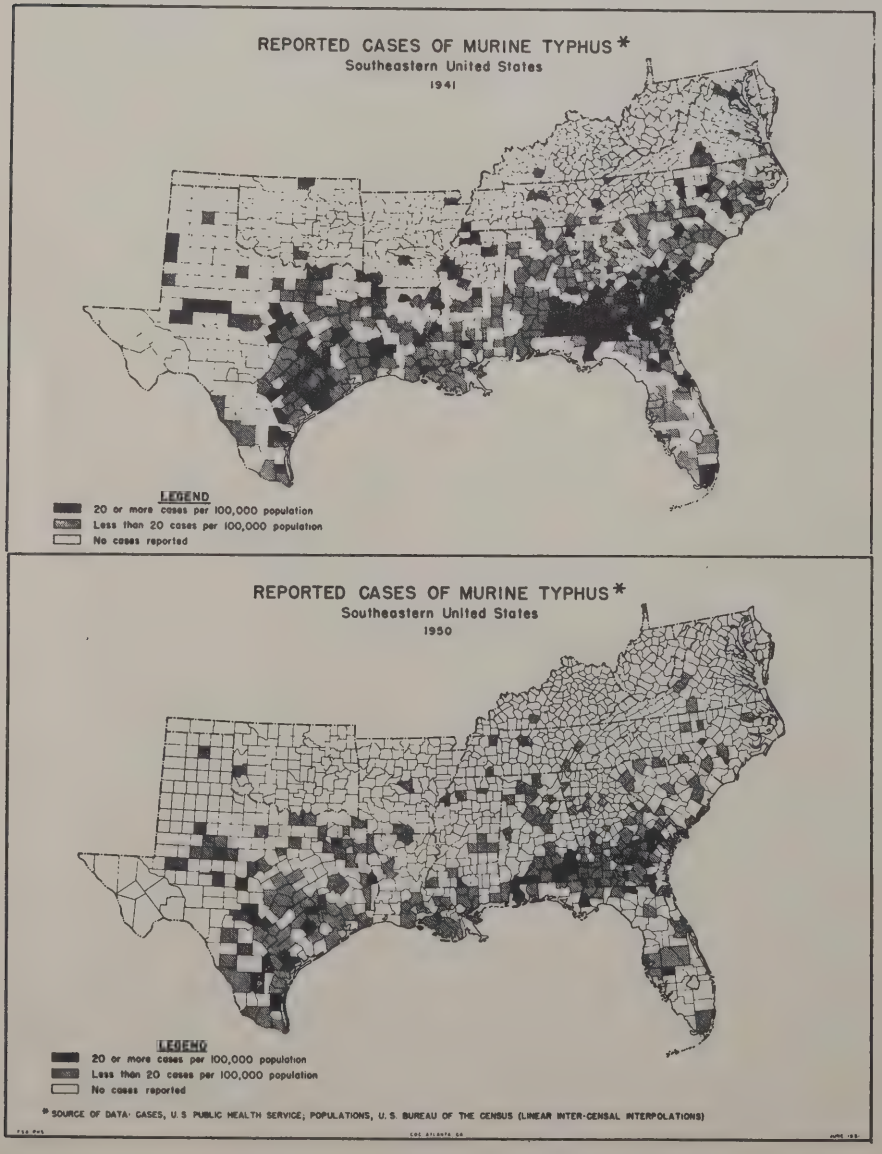


Chart showing the world-wide distribution of murine typhus fever and the murine plague.

Comparative charts indicating the percentage of eradication and control of murine typhus in the Southeastern United States in the ten year period from 1941 to 1950.


REPORTED CASES OF MURINE TYPHUS*
Southeastern United States
1941
LEGEND
20 or more cases per 100,000 population
Less than 20 cases per 100,000 population
No cases reported
REPORTED CASES OF MURINE TYPHUS*
Southeastern United States
1950
LEGEND
20 or more cases per 100,000 population
Less than 20 cases per 100,000 population
No cases reported
* SOURCE OF DATA: CASES, U.S. PUBLIC HEALTH SERVICE; POPULATIONS, U.S. BUREAU OF THE CENSUS (LINEAR INTER-CENSAL INTERPOLATIONS)

The body louse has been associated with typhus fever, relapsing fever and trench fever. Typhus fever has been one of the great spectres associated with war, famine, poverty and distress. During the first World War, it took a terrific toll in Austria, Hungary, Serbia, Poland, Russia and Roumania. In Serbia alone, during the winter of 1915–16, it is estimated that at least 150,000 people succumbed to typhus fever. From 1918–1923, approximately 7,000,000 cases of typhus fever were reported from Russia, exclusive of the Ukraine. The disease is associated with overcrowding and lack of personal cleanliness.

In 1909, Nicolle, Compte and Conseil demonstrated that typhus fever was transmitted by the bite of the body louse. Since then, great campaigns have been waged to disinfest large populations and their infested clothing. It is to the everlasting credit of the U. S. Armed Forces that millions of men have been returned to the United States from lice infested areas throughout the world without producing a single case of lice-borne disease in this country. The widespread use of DDT for disinfesting purposes during World War II among the American and British military forces and their allies was a very significant aid in suppressing typhus fever and other Rickettsial diseases. The historic use of DDT to suppress typhus fever among the inhabitants of Naples, Italy, as well as among the American troops following the evacuation of the German Army during World War II and the destruction of the water works and the electric generating plant and other public works of great sanitary significance, will always represent a brilliant chapter in preventive sanitation. While an effective typhus fever vaccine was available to immunize the American armed forces during World War II, it was the use of DDT coupled with personal cleanliness that was responsible for keeping typhus fever under control.

In the United States, the prevalent form of typhus fever is known as endemic or murine typhus as opposed to the European variety, which is known as epidemic typhus fever. Endemic typhus is prevalent mostly in our Southern states and is associated with rats. It is transmitted to man through the bite of the rat flea. This remarkable discovery was made by

Maxey and Dyer in the United States and paved the way for an intensified rodent control program. Here too, however, the use of DDT for dusting rat runs has been exceedingly helpful in controlling this form of typhus fever. The coats of the rats become covered with DDT and the flea population resident on the rats as ectoparasites are killed by contact with this insecticide.

Rickettsial diseases other than typhus fever. Other Rickettsial diseases which have been combatted with DDT as well as other sanitary and public health procedures have been Rocky Mountain Spotted Fever transmitted by ticks; Tsutsugamushi Fever also known as scrub typhus and Japanese River Fever, transmitted by mites; and Rickettsialpox likewise transmitted by mites found on domestic mice. A recent outbreak of this last disease occurred on Long Island, N. Y.

Insect Pests

MAN'S STRUGGLE against the insects that carry disease and those that infest and consume his crops and his food supply has been second only to his struggle against the pathogenic microorganisms that invade his body and use it as a culture medium. The development of extensive and convenient plumbing facilities for carrying pure hot and cold water under pressure and the development of safe and conveninent sewerage facilities for removing the wastes from the body, the home, the industry and the community environment, have been of paramount importance as aids in achieving man's ascendancy over those smaller forms of life which have vied with him for mastery and even for survival. Coupled with sanitation, man developed cookery to protect his food supplies and to make them more readily digestible. He also developed a large array of insecticides which have helped him to combat insect pests of all types successfully.

By studying the life cycle and habits of each pest, he has learned how to combat the depredaceous and infective insects by controlling their breeding and limiting their food supply. Life exhibits on all sides the inexorable struggle for survival. The price of survival and mastery for man is scientific knowledge and its constant applications. Sanitation is the achievement of field and laboratory investigation and the social heritage it represents will be passed on to countless, unborn generations. To be effective, sanitary control must remain unbroken and uninterrupted for it is the thin veneer that separates civilization as we know it from the primitive, intolerable environmental conditions of our recent ancestors.

Military sanitation value demonstrated. The value of sanitation and other aspects of the modern public health program may be demonstrated in many ways, not the least important of which is our national experience in time of war. General Simmons[2] states that "in the U. S. Army alone, more than ten million men were mobilized during World War II to serve in some of the most unhealthful regions of the world; yet the disease rates among the troops were lower than in any of our former wars. There were no great epidemics and the disease death rate was only 0.6 per 1,000. When this low figure is compared with the rate of 15.6 for World War I and 25 for the Spanish-American War, it is obvious that America has found the key to a really effective future health program." As Winslow, Boudreau and Hume have stated, "public health science has at its disposal today defensive weapons of unparalleled power and effectiveness."

The control of tetanus. Mention has been made already of the suppression of louse-borne and fly-borne diseases during World War II through sanitation, good personal hygiene, immunization and the use of DDT. Tetanus was another military hazard and the development of tetanus toxoid as an immunizing agent against tetanus was an outstanding recent achievement in sanitary science. Raymond W. Bliss, Surgeon-General of the U. S. Army states that "during the war years, 1942–1945, there were only 12 cases of tetanus in the entire United States Army. Six of these had not received the prophylactic vaccine. Two others had had the basic immunization but no post-injury dose. Four were vaccinated but failed to demonstrate sufficient resistance. In unvaccinated Japanese forces during the same four-year period, tetanus was diagnosed in 10 per 100,000 wounded men. The Germans and British experienced many more cases than occurred among our troops. As for typhus incidence, American soldiers in Germany accounted for a grand total of 5 cases. All were mild and in none was the outcome fatal."

Diatomaceous-earth filters. Another important sanitary advance achieved during World War II was the development of the diotomaceous-earth filter for removing the cysts of amoebic dysentery from water supplies. This treatment coupled with chlorination was successful in making water supplies infected with amoebic dysentery, potable and safe.

Quinine substitutes. Concerning the use of quinine substitutes in keeping malaria under control during World War II, General Bliss states, "Atabrine was processed and manufactured on a large scale in this country during the war years. One hesitates to think how we could have functioned militarily in the Southwest Pacific and other malarious areas without atabrine for suppressive treatment. Thousands of other chemicals have been tested and surveyed in the continued search for a better suppressive drug or a true causal prophylactic against malaria. At present chloroquine is the drug of choice, for both suppressive and clinical treatment."

Sulfa drugs and antibiotics. Mention should be made of other agents now extensively used in the treatment and prevention of disease. The introduction of the sulfa drugs and the discovery and mass production and use of certain effective antibiotics have completely revolutionized the treatment of many serious and fatal diseases. Penicillin is remarkably effective against the Gram positive pathogenic organisms, most of which are coccus forms. Streptomycin has been found to be an important aid in the treatment of tuberculosis. Aureomycin is effective against the Gram negative pathogenic bacilli while chloromycetin holds great promise in the control and treatment of rickettsial diseases.

Achievements in U. S. Navy

THE EXPERIENCE of the U. S. Navy during World War II parallels that of the U. S. Army and

emphasizes the great role which superior knowledge and application of sanitary science played in the winning of the War. Surgeon-General C. A. Swanson of the U. S. Navy states that "malaria took the lead as a regiment wrecker early in the Pacific war, while military effectiveness was decreased to an alarming degree in many areas by diarrhea and dengue. It soon became apparent that manpower, equipment and supplies for mosquito and fly control would have to receive a very high priority, on a par with food and ammunition. Every known method of malaria control was exploited. The most dramatic measure, of course, was the development of the various techniques of using DDT.

"It is well established that the Japanese on Guadalcanal suffered from malaria and other diseases far more severely than did our troops. Indications are that virtually every enemy soldier who landed on the island was infected with malaria within a month or six weeks after landing. Not only was the incidence almost universal, but the severity of the infections was far greater than in our forces. The Japanese used no effective repellants and few mosquito nets and had no effective system of atabrine or quinine suppressive medication. In our forces, these measures were delayed in initiation and incomplete in execution, but they did preserve much vitally needed man power.

"It has been estimated that fully two-thirds of the Japanese who met their demise on Guadalcanal died of disease. The highest known estimate of enemy battle casualties does not exceed 10,000, and in all probability the correct figure is less. Thus of the 42,000 Japanese believed to have faced us on Guadalcanal, less than one-quarter were killed in action or died of wounds, less than one-quarter were evacuated and well over one-half—more than 20,000—perished from disease. In contrast, American dead and missing during the campaign were fewer than 1500.

"Whether this figure of 20,000 represents the margin between victory and defeat is difficult to say with certainty, but a close analysis of the fighting indicates that disease in the enemy forces may well have been the agency tipping the scales in our favor during the critical battles along the Mantanidan, when the enemy attacks were repulsed by a narrow margin.

"The results achieved during the war in disease prevention and in the treatment of the sick and wounded clearly demonstrate what can be done by a unified effort with the tools at hand today. No devastating epidemics swept the service during the recent war, whereas previously epidemics have been counted as the natural accompaniment of war. The reduction in the non-combat death rate, as compared with that of World War I, effected a saving of more lives than the total number lost through enemy action. During the war, the average strength of the Navy for the four years was in the neighborhood of 2,500,000. During this time there were only 8 cases of smallpox, 96 of typhoid, and 4 of tetanus, with 2 deaths from tetanus among individuals whose records indicated that their immunization had been incomplete. No combat casualty developed tetanus. 615 cases of the typhus group of diseases were reported, the majority being tsutsugamushi fever in the Southwest Pacific campaigns. There were no cases of cholera, plague or yellow fever.

"It seems certain that the majority of our people do not appreciate all the wonders that our way of life, modern medicine and modern public health methods have brought us. In the last two years (1947–1949) I have visited the principal inhabited countries of the globe and have come to realize with awe how fortunate we in America are. Millions in foreign lands are semi-starved; tuberculosis is rampant; and shelter and clothing are woefully inadequate. An observer's attention is first arrested by the colossal destruction and devastation which the past war accomplished, but these conditions are overshadowed by the extensive, dumb human misery."

PART FOUR

JANUARY 1952

ONE OF the most noteworthy achievements of the modern public health movement, particularly in the field of sanitation, has been the sanitating of the alimentary tract of man. In this country, typhoid fever has been reduced to the vanishing point and other forms of gastro-enteritis have likewise been greatly diminished. Infant and child mortality have been greatly reduced and milk-borne diseases have been prevented through the widespread use of pasteurization and the improvement of sanitary practices in milk production. Even a respiratory disease like tuberculosis has been reduced enormously and it is doubtless true that the control of the gastro-enteric infections has played an indirect role in this phenomenon by preventing debilitating disease and thus lowering vital resistance. Furthermore the universal adoption of pasteurization and the program of tuberculin testing of dairy cows have been responsible for the control of milk-borne tuberculosis. In addition, the control of insects that serve as vectors of disease has added to the magnificent achievements in the prevention of disease and premature death and in the prolongation of life through the effective control of the environment.

Many factors have been responsible for the control of typhoid fever and other gastro-enteric infections, but the most important are unquestionably the following:

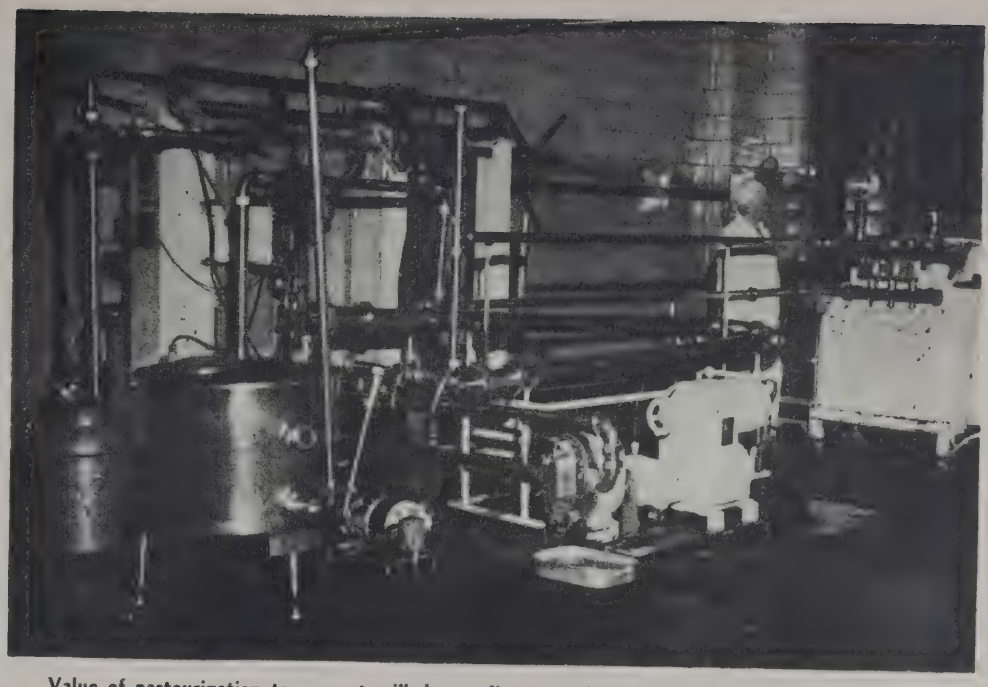
1. The purification and disinfection of water supplies.
2. The provision of sewerage facilities and sanitary methods of excreta disposal and the treatment of sewage before final disposal.
3. The sanitation and pasteurization of milk supplies.
4. The immunization of the population against typhoid and paratyphoid fevers.
5. The control of flies.
6. The development of laboratory methods for diagnosing typhoid fever and other enteric infections.
7. The detection and control of typhoid carriers.
8. The improvement in medical and nursing care.
9. The education of the people in the principles of good hygiene and sanitation.
10. The more effective protection of shellfish and other food supplies.

In Massachusetts, during the six years 1894–1899, the number of cases of typhoid fever reported per year was 2,420 and the average number of

annual deaths was 672. If we assume the existence of 10 cases per death for typhoid fever, there were in all probability over 6700 cases per year in Massachusetts around the close of the nineteenth century. Conversely, during the six years from 1943–1948, the average number of cases of typhoid fever per year in Massachusetts was 51 and the average number of deaths from typhoid fever per year was 1.7. This improvement occurred despite the increase in population from 2,800,000 in 1900 to approximately 4,500,000 in 1950. If the ratio of deaths to population prevailing from 1894–1899 had continued during the period 1943–1948, there would have been over 1100 deaths from typhoid fever per year instead of 51 which actually occurred.

Decline of milk-borne disease in Massachusetts. The decline in milk-born diseases in Massachusetts has also been impressive and undoubtedly reflects the improvement which has taken place in other parts of the country. Milk may be a vehicle of many diseases such as typhoid fever, bacillary dysentery, undulant fever, septic sore throat, scarlet fever, diphtheria and tuberculosis. In Massachusetts, it is estimated that even today 1 cow in 6 is infected with Bang's disease or contagious abortion, and that 1 cow in 200 is infected with tuberculosis. There is no doubt that the accredited herd plan fostered by the Bureau of Animal Industry of the U. S. Department of Agriculture has done a great deal to control tuberculosis in dairy cows, but it is unquestionably true that the problem of bovine tuberculosis in man resulting from the consumption of tuberculous milk could only have been solved effectively through the universal adoption of pasteurization. In 1910, only a negligible amount of milk in Massachusetts was pasteurized. In 1919, 15 per cent was pasteurized; in 1923, 55 per cent; in 1930, 80 per cent; and in 1939, 85 per cent. In the period 1946–1948, it was estimated that 95 per cent of all milk sold in Massachusetts was pasteurized. In consequence there has been a precipitous decline in the cases of milk-borne disease.

Of the 8,404 cases listed in Table 1, 5,555 were cases of septic sore throat; 1,400 were cases of typhoid fever; 978 were cases of scarlet fever; 168 were cases of gastro-enteritis; 159 were cases of dysentery; and 29 were cases of undulant fever. The value of pasteurization as a means of preventing milk-borne outbreaks of disease is definitely established by the data in the preceding table. Boston made the sale of raw milk, other than certified milk, illegal in 1928. In 1950, 112 cities and towns in Massachusetts have similar milk regulations. Furthermore, nearly 85 per cent of the population of the Commonwealth lives in these communities. They include every city and town having a population of 25,000 or more. Similar action has been taken by one town with a population of only 872.



Value of pasteurization to prevent milk-borne disease outbreaks has been established.

A review of the situation in the Commonwealth shows that the communities which do not require pasteurization consist of 202 with a population under 5,000; 31 with a population between 5,000 and 10,000; 3 with a population between 10,000 and 15,000; and 3 with a population between 15,000 and 25,000. In short, the problem of milk-borne disease in Massachusetts today is the problem of the rural and small community. This conclusion is further supported by the data in Table 2.

Table 1

Outbreak of Disease in Massachusetts 1911–1948
Due to Infected Fluid Milk*

Period	Number of Outbreaks	Total Cases	
		Group A	Group B
1911–1915	46	4,255	0
1916–1920	33	1,287	20
1921–1925	17	444	0
1926–1930	14	1,513	146
1931–1935	8	220	16
1936–1940	4	283	48
1941–1945	4	46	86
1946–1948	1	0	40
Totals	126	8,048	356

Group A includes diphtheria, scarlet fever, septic sore throat and typhoid fever.
Group B includes dysentery, gastro-enteritis and undulant fever.

* The author is indebted to Dr. Roy F. Feemster of the Massachusetts Department of Public Health for the data in Tables 1 and 2 and for the information pertaining to malaria in Massachusetts.

Table 2

Per Cent of Milk Pasteurized in Massachusetts Communities 1923 & 1944

Population Group	1923	1944
50,000 and over	82.3	99.7
25,000–50,000	65.1	99.0
15,000–25,000	43.4	97.1
10,000–15,000	10.8	84.8
5,000–10,000	*	81.3
2,500– 5,000	*	79.4

* Data not available.

Progress Against Malaria

MALARIA, which is another disease due to an uncontrolled, defective environment, has not been a significant cause of disease and death in Massachusetts during recent years. During the five-year period, 1935–1939, prior to the mobilization of the armed forces of the U.S.A. and their actual participation in World War II, the cases of malaria reported in Massachusetts averaged 14 per year and the deaths from malaria during the same period averaged one per year. Because of the exposure of American troops to malaria in various parts of the world during World War II, there has been a substantial increase in the number of cases of malaria reported in Massachusetts during 1942–1948. During this period, 2360 cases and 19 deaths from malaria were reported among Massachusetts residents. Of this number, 2,112 cases or 89.5 per cent were reported in 1944, 1945, and 1946. Similarly, 10 of the 19 deaths from malaria referred to above were reported during the same years. In 1948, the last year for which information was available, there were only 23 cases and 2 deaths from malaria reported. None of the cases of malaria occurring between 1942 and 1948 actually had its origin in Massachusetts. Many of the deaths reported should actually have been assigned to some other cause, since communicable diseases take precedence over other causes in the classification of the causes of death.

Massachusetts, however, was not always relatively free from malaria. During the decade 1890–1899, the average number of deaths from malaria was 74 per year. During the decade 1900–1909, the average number of deaths per year was 44; during the decade 1910–1919, it was 7.5; and during the decade 1920–1929, it was only 3.3. Nevertheless, as recently as 1915 and 1916, there were 112 and 97 cases respectively reported.

For the country as a whole, malaria seems to be a vanishing disease despite the large and populous area in the South which is still heavily infested with Anopheles mosquitoes. During the 12-month period from October 1, 1948 to September 30, 1949, there were only 5,238 cases of malaria reported for the entire country. Of this number, 3,227 cases or 61.6 per cent were reported from Texas; 699 cases or 13.3 per cent from South Carolina; 400 cases or 7.7 per cent from Arkansas; and only 912 cases or 17.4 per cent from the rest of the country. This remarkable improvement over the conditions that prevailed during the early years of the present century has been accomplished through active campaigns aimed at the elimination of mosquito breeding places, the use of various larvicides and more recently the use of DDT sprays against mosquito larvae and the adult mosquito itself.

F. L. SOPER

On a world-wide basis, great progress has also been made against mosquito and other insect-borne diseases during the past 50 years. From the standpoint of the control of insect-borne diseases, World War II, which was waged on a global scale, was a great success. In this wonderful saga of man's supremacy over his insect enemies, DDT played a remarkable role as the mass executioner of lice, fleas, mosquitoes and flies. Thus malaria, epidemic typhus, plague, dysentery, dengue fever, filariasis and sand fly fever were kept under control. The lethal effects of DDT on insects resulting merely from contact, coupled with its prolonged residual lethal effect when applied to surfaces with which the insects might come in contact, provided a powerful and remarkably cheap weapon for combating the disease-bearing insects.

The control of insect-borne diseases represents another brilliant chapter in the history of sanitary science. This achievement has controlled disease, prolonged life and opened vast areas of the world for safe, human habitation and enterprise. The total elimination of Anopheles gambiae from northeast Brazil by F. L. Soper and D. B. Wilson beginning in 1942, and the duplication of the same achievement in upper Egypt a little later indicates that the regional control of insect-borne disease is feasible and practical. Similar dramatic results have been obtained against Aedes aegypti. Bolivia is already free of this insect vector of disease and Chile, Ecuador and Brazil are nearing this goal.

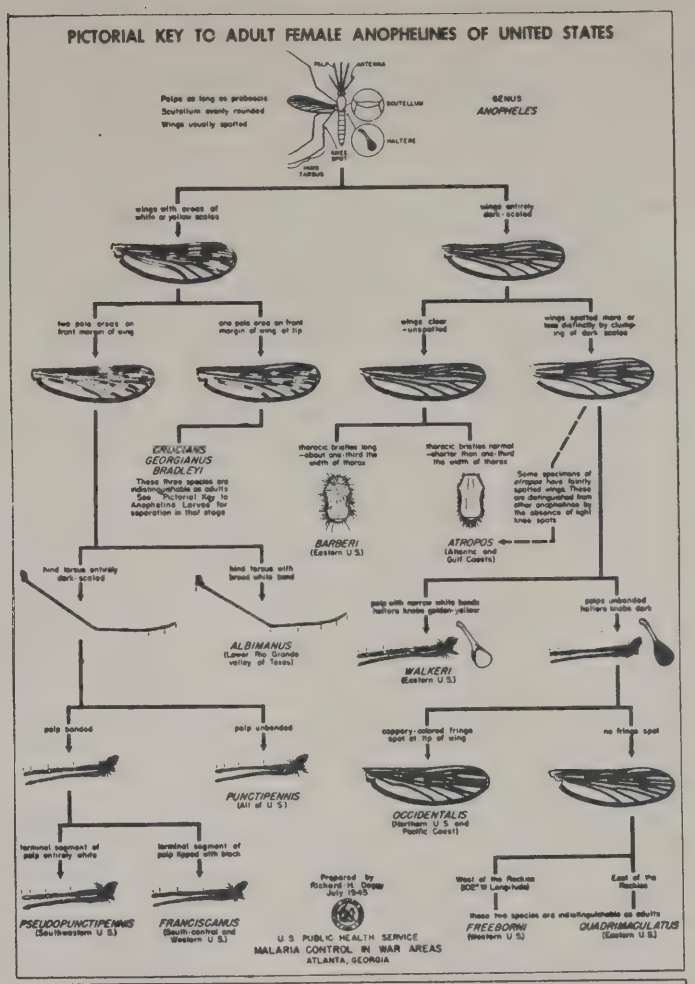
During the postwar period, great progress has been made towards the virtual elimination of anopheline mosquitoes in Sardinia, Cyprus and Tobago, areas that have been heavily infested throughout history and where malaria has long been very prevalent. While biological extermination of any species is exceedingly difficult, especially when the lower forms of life are involved, the facilities are now available for achieving this goal on a regional basis at a relatively low cost where insects are concerned. Since insect-borne diseases are transmitted only, or perhaps largely, through the medium of

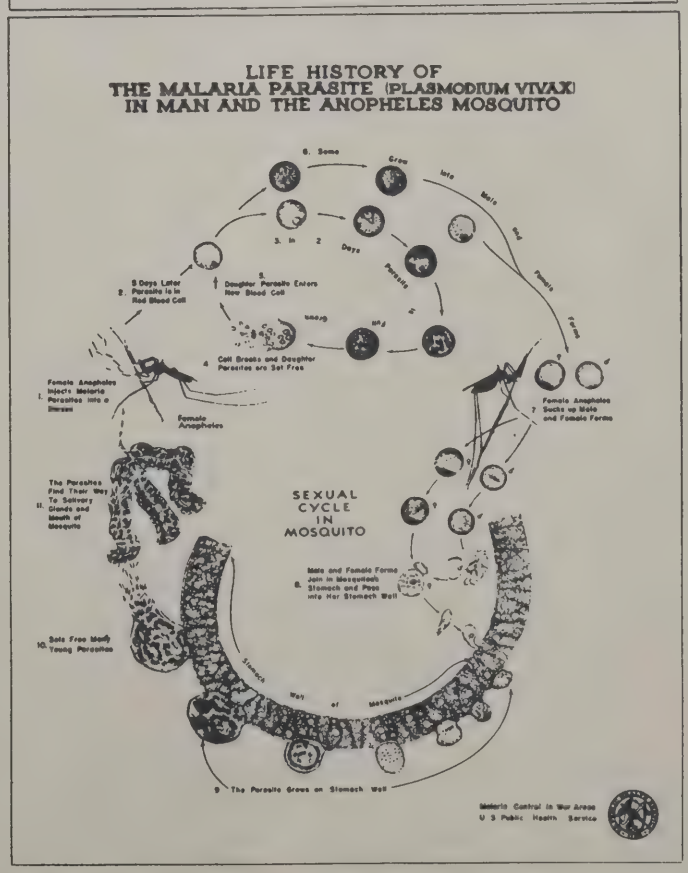
specific insects, it follows that the elimination of such insects must result in the control of the serious diseases they transmit. Even the control of trypanosomiasis or African sleeping sickness, spread by the Glossina or tsetse fly in equatorial Africa may be accomplished through the use of contact, insecticidal sprays. This method of combating insects, coupled with the elimination of their breeding places, should prove wonderfully effective. The significance of such an achievement to the welfare of the world is almost immeasurable.

Food-Drink Sanitation

THE GREAT progress which has been made in the control of water-borne and milk-borne disease in the United States, and the progress made in the safe disposal of human excreta and in the control of the insect vectors of disease have naturally created new activities in the field of environmental sanitation. One of the fields that has been explored quite assiduously during recent years has been the area of food, beverage and restaurant sanitation. With the industrialization and commercialization of many of the home activities that revolved around the kitchen, it has been necessary to broaden the scope of the community program in environmental sanitation. The making of bread, pies, pastries, desserts, soups, and preserved foods of all kinds is now largely performed in industry. Similarly, slaughtering and the preparation of the rich gamut of foods that revolves around the packing industry, have been taken out of the home and industrialized. This has made it necessary to have Federal, State and Municipal supervision over food processing and food dispensing establishments and over all the foods and beverages that originate in them. Not only does the gigantic food industry present problems of sanitation, microbic infection and spoilage, but also problems of metallic and chemical poisons. The latter are often derived from the equipment, or the insecticides and rodenticides that are employed. Sometimes microbic inhibitors are employed and various agents are used to prolong the freshness of the food, its taste, appearance and texture. These are not always free of public health significance.

It is estimated that there are over




LIFE HISTORY OF
THE MALARIA PARASITE (PLASMODIUM VIVAX)
IN MAN AND THE ANOPHELES MOSQUITO
SEXUAL CYCLE IN MOSQUITO
Malaria Control in War Areas
U.S. Public Health Service

Charts courtesy U. S. Public Health Service.

Upper chart shows pictorial key to female anophelines of United States. Lower chart shows life history of malaria parasite in man and mosquito.

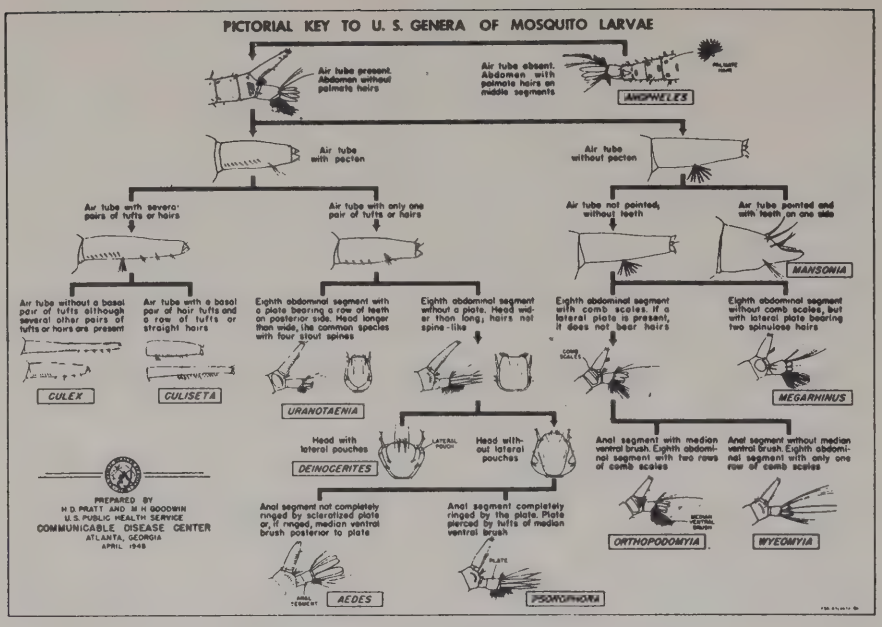

PICTORIAL KEY TO U. S. GENERA OF MOSQUITO LARVAE
Air tube present. Abdomen without palmate hairs
Air tube absent. Abdomen with palmate hairs on middle segments
ANOPHELES
Air tube with pecten
Air tube without pecten
Air tube with several pairs of tufts or hairs
Air tube with only one pair of tufts or hairs
Air tube not pointed, without teeth
Air tube pointed and with teeth on one side
MANSONIA
Air tube without a basal pair of tufts although several other pairs of tufts or hairs are present
Air tube with a basal pair of hair tufts and a row of tufts or straight hairs
CULEX
CULISETA
Eighth abdominal segment with a plate bearing a row of teeth on posterior side. Head longer than wide, the common species with four stout spines
Eighth abdominal segment without a plate. Head wider than long; hairs not spine-like
URANOTAENIA
Eighth abdominal segment with comb scales. If a lateral plate is present, it does not bear hairs
Eighth abdominal segment without comb scales, but with lateral plate bearing two spinulose hairs
MEGARHINUS
Head with lateral pouches
Head without lateral pouches
DEINOCERITES
Anal segment with median ventral brush. Eighth abdominal segment with two rows of comb scales
Anal segment without median ventral brush. Eighth abdominal segment with only one row of comb scales
ORTHOPODOMYIA
WYEOMYIA
PREPARED BY H. D. PRATT AND M. H. GOODWIN U.S. PUBLIC HEALTH SERVICE COMMUNICABLE DISEASE CENTER ATLANTA, GEORGIA APRIL 1948
Anal segment not completely ringed by sclerotized plate or, if ringed, median ventral brush posterior to plate
Anal segment completely ringed by the plate. Plate pierced by tufts of median ventral brush
AEDES
PSOROPHORA

Chart showing pictorial key to U. S. genera of mosquito larvae.

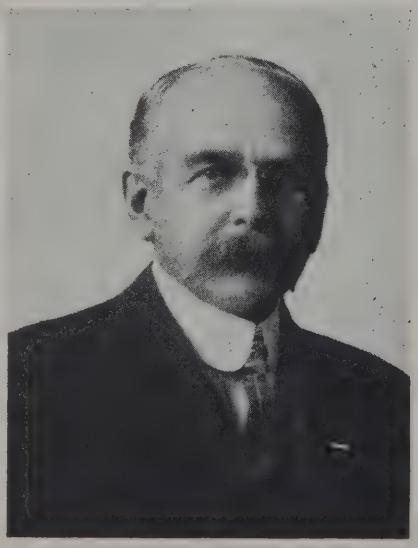
525,000 public eating and drinking establishments in the United States and that over 68,000,000 meals are served daily in public food establishments. There are over 310,000 restaurants and cafeterias; 41,500 drugstores and ice cream parlors; 28,000 industrial cafeterias and restaurants; 31,600 school cafeterias; and 31,800 clubs and lodges that serve meals. Food and drink are also served in hotels, boarding houses, hospitals and institutions, summer camps, taverns, canteens, churches, trains, planes and various other places. In consequence, there are over 20 billion meals eaten annually in the United States in the various public eating establishments.

It can be seen, therefore, that the problems of collecting, transporting, storing, refrigerating, processing, preparation, and serving of food in the United States are enormous and in consequence that many problems in sanitation result. The existing situation is tremendously complicated because of the large number of untrained or partially trained people who are intimately involved as food handlers. In public eating and drinking establishments, the situation is further aggravated tremendously through the common use of eating and drinking utensils since these have to be sanitized rapidly and effectively several times during each meal. While it is impossible to state specifically how much infection is transmitted in this way, the opportunities for the reciprocal exchange of saliva and excretal contaminations are so great that the public eating and drinking establishment must be regarded as a potential menace to the public health at all times.

The significance of this public health problem has been recognized throughout the United States in various ways. 1. By the development of food handler training programs in many communities; 2. by the organization of periodic sanitary inspections by the local health authorities; 3. through the development of restaurant sanitation codes; 4. through the establishment of a system of supervising the sanitizing of eating and drinking utensils by examining bacteriologically thousands of swab rinse samples; and 5. through extensive subsidized research on detergents and mechanical dishwashing.

The dispensing of food and drink in public places has presented a public health problem of increasing magnitude not only because of its gigantic size and because the personnel involved is largely untrained, but also because of the increased use of vending machines. While an effort is being made to maintain these machines in a sanitary manner, their supervision and regulation by official public health authorities have not yet been properly organized. Particular attention will have to be directed toward the cleanliness of all vending equipment; to the safety of all food and drink stored therein; to the proper refrigeration of foods and drinks that must be kept cold; and, conversely, to proper temperatures of heating for those foods and drinks that must be kept hot. The price of safety is eternal vigilance.

GEORGE C. WHIPPLE



Food-Borne Outbreaks

SATISFACTORY control of public water supplies in the United States since 1900 and the tremendous improvement in the safety of municipal milk supplies through sanitation and pasteurization resulted in reducing the annual number of outbreaks of water-borne and milk-borne diseases. Simultaneously, however, the growing importance of food-borne outbreaks of disease has been accentuated. In 1948, there were 21 outbreaks of water-borne disease reported in the United States. These were responsible for 619 cases and 4 deaths. At the same time, there were 17 epidemics due to milk and dairy products. These resulted in 613 cases of disease and 2 deaths. During the same year however, there were 327 food-borne epidemics, resulting in 9,962 cases of disease and 17 deaths. The food-borne epidemics were 16 times as numerous as the water-borne outbreaks and 19 times as frequent as the epidemics due to milk and dairy products. Food-borne outbreaks were responsible for 8 times the number of cases of disease and 3 times the number of deaths produced jointly by water and dairy products. The transformation in this picture is astonishing.

The Milk and Food Branch of the Division of Sanitation of the U. S. Public Health Service* has been compiling the reports on the out-

* The author is indebted to Mr. A. W. Fuchs, of the U. S. Public Health Service for the data in table 3.

Table 3

Summary of Disease Outbreaks from Water, Milk and Milk Products, Other Foods and Undetermined Vehicles[1]

Year	Water			Milk and Milk Products			Other Foods			Undetermined			Total		
	Outbreaks	Cases	Deaths	Outbreaks	Cases	Deaths	Outbreaks	Cases	Deaths	Outbreaks	Cases	Deaths	Outbreaks	Cases	Deaths
1938	48	31,693*	17	42	1,685	27	70	2,247	25	8	882	3	168	36,507*	72
1939	43	2,254	3	41	2,509	7	146	3,770	12	17	1,203	6	247	9,736	28
1940	43	44,184‡	9	43	1,678	10	218	5,588	30	18	1,088	1	322	52,538‡	50
1941	60	12,039	24	37	1,049	4	223	6,070	53	20	1,876	24	340	21,034	105
1942	53	13,271	9	45	2,142	2	245	11,420	101	37	1,878	10	380	28,711	122
1943	26	5,712	15	40	1,590	7	285	13,938	33	38	2,525	1	389	23,765	56
1944	32	2,686	1	41	1,449	20	298	14,558	45	22	1,683	1	393	20,736	67
1945	26	5,850	6	29	2,161	17	276	11,547	57	12	637	2	343	20,204	82
1946	32	4,512	2	19	795	0	299	12,526	17	6	312	1	356	18,145	20
1947	24	6,125	1	22	253	7	316	12,536	29	27	1,392	8	389	20,306	45
1948	21	619	4	17	613	2	327	9,962	17	10	446	5	375	11,660	28
Total	408	128.954	91	376	15,924	103	2,703	104,162	419	215	13,942	62	3,702	262,982	675

[1] As reported by state and municipal health departments.

* Including a water-borne outbreak of gastroenteritis with 29,250 cases.

‡ Including a water-borne outbreak of gastroenteritis with 35,000 cases.

breaks of disease in the United States due to water, milk, dairy products and foods since 1938. The resulting data obtained from reports received from State and municipal health departments are recorded in Table 3. It should be remembered that most cases of food-borne disease are never seen by a physician and are never reported. Usually it is only when a food-borne outbreak of disease is serious in its symptomatology and when it affects a large number of people that its character is recognized, investigated and recorded. Hence, food-borne infections are far more numerous and far more significant than the available statistical evidence would indicate.

In 1948, milk and dairy products were responsible for one epidemic of typhoid fever, resulting in 11 cases; one outbreak of scarlet fever and septic sore throat, resulting in 67 cases; two epidemics of dysentery, resulting in 126 cases; 11 outbreaks of food infection and gastro-enteritis, resulting in 350 cases; and 2 miscellaneous outbreaks of disease producing 59 cases. One death resulted from dysentery and one from food infection and gastro-enteritis. Interestingly enough, there were no outbreaks of undulant fever, diphtheria and paratyphoid fever.

Food-borne outbreaks in 1948. The food-borne outbreaks of disease occurring in the United States in 1948 other than through milk and dairy products were distributed as follows. There were 7 outbreaks of botulism resulting in 30 cases and 6 deaths; 5 outbreaks of chemical food poisoning resulting in 74 cases and one death; one outbreak of dysentery resulting in 120 cases; 289 epidemics of food infection and gastroenteritis resulting in 8,832 cases and 7 deaths; one epidemic of scarlet fever and septic sore throat, resulting in 270 cases; 14 epidemics of trichinosis, resulting in 94 cases and one death; 4 epidemics of typhoid and paratyphoid fevers, resulting in 30 cases and one death; and 6 miscellaneous outbreaks that were not identified, resulting in 512 cases and one death.

Water-borne outbreaks in 1948. The 21 water-borne outbreaks of disease recorded in the United States in 1948 affected the smaller communities mostly, since in 15 instances the population involved was under 10,000. The diseases involved were typhoid and paratyphoid fevers, gastro-enteritis not otherwise identified and the Flexner variety of bacillary dysentery. Most of the epidemics were due to back siphonage, cross connections, inadequate chlorination and sewage pollution. The public water supply was involved in only four instances of the 21 recorded.

PART FIVE

FEBRUARY 1952

VARIOUS METHODS have been employed in this discussion to demonstrate the great progress that has been achieved in sanitation since 1890. There remains, however, one additional method of appraising the public health significance of this progress which has not been fully explored. While the general death rate has been greatly diminished since 1890 and the average life span at birth has been greatly prolonged, these gains in public health are not due to improvements in environmental sanitation alone.

The introduction of biological products for the diagnosis, immunization and treatment of disease has played an important role in the control of many communicable diseases including typhoid fever, diphtheria, smallpox, whooping cough, measles, tetanus and even some of the insect-borne diseases. The discovery of the sulfa drugs and various antibiotics and their wide use in treatment have resulted in the control of many diseases including pneumonia, the pyo-

genic infections, meningococcus meningitis, the venereal diseases and various insect-borne and gastro-intestinal diseases. Even tuberculosis has been amenable to some extent to BCG vaccine and streptomycin.

Discoveries in nutrition have paved the way for the prevention and control of nutritional diseases and discoveries in pharmacology and industrial toxicology have paved the way for the control of certain industrial diseases. Similarly, remarkable improvements in surgery, in medical diagnosis and treatment, in nursing care and in health education have unquestionably played an exceedingly important role in the prevention of premature death and in promoting good health.

Nevertheless, there are certain diseases that have been virtually controlled through improvements in environmental sanitation and there are other diseases that are not spread through a defective environment that have been affected indirectly and to a marked degree by the conquest of debilitating diseases spread through defective sanitation. Unquestionably, this has been true of tuberculosis to a substantial degree although the exact magnitude of this phenomenon is difficult to measure.

The diseases which are spread through a defective environment are the gastro-enteric diseases, the insect-borne diseases and many of the industrial diseases. In the United States the most important gastro-intestinal diseases have been typhoid and paratyphoid fevers, dysentery and diarrhea and enteritis under 2. Undulant fever and non-pulmonary tuberculosis of bovine origin might also be included. In addition, there are certain respiratory diseases such as diphtheria, scarlet fever and septic sore throat which may be spread through infected milk. The various food-borne diseases have already been discussed. Likewise, the insect-borne diseases have received some consideration.

It is possible, therefore, to evaluate sanitary progress since 1890 through a study of the vital statistics with particular reference to the deaths resulting from infected water, milk and dairy products, foods and insects. Such data are available for Massachusetts since reliable vital statistics for this state go back to 1880 or earlier. Such data are also available for Boston since it also has

Table 4

Deaths (Exclusive of Stillbirths): Number and Rate in the United States Death Registration Area, 1880 To 1947

Year	Population of Death Registration Area	Total Number Deaths	Rate Per 1,000 Population
1880	8,538,366	169,453	19.8
1890	19,659,440	386,212	19.6
1900	30,765,618	539,939	17.6
1901	31,370,952	518,207	16.5
1902	32,029,815	508,640	15.9
1903	32,701,083	524,415	16.0
1904	33,345,163	551,354	16.5
1905	34,052,201	545,533	16.0
1906	41,983,419	658,105	15.7
1907	43,016,990	687,034	16.0
1908	46,789,913	691,574	14.8
1909	50,870,518	732,538	14.4
1910	53,831,742	805,412	15.0
1911	59,183,071	839,284	14.2
1912	60,359,974	838,251	13.9
1913	63,200,625	890,848	14.1
1914	65,813,315	898,059	13.6
1915	67,095,681	909,155	13.6
1916	71,349,162	1,001,863	14.0
1917	74,984,498	1,068,932	14.3
1918	81,333,675	1,471,367	18.1
1919	85,166,043	1,096,436	12.9
1920	87,632,592	1,142,558	13.0
1921	89,102,434	1,032,009	11.6
1922	93,866,240	1,101,863	11.7
1923	97,816,104	1,193,017	12.2
1924	100,082,062	1,173,990	11.7
1925	102,951,999	1,219,019	11.8
1926	104,938,301	1,285,927	12.3
1927	108,177,568	1,236,949	11.4
1928	114,258,516	1,378,675	12.1
1929	116,317,515	1,386,363	11.9
1930	118,560,800	1,343,356	11.3
1931	119,421,000	1,322,587	11.1
1932	120,122,000	1,308,529	10.9
1933	125,578,763	1,342,106	10.7
1934	126,373,773	1,396,903	11.1
1935	127,250,232	1,392,752	10.9
1936	128,053,180	1,479,228	11.6
1937	128,824,829	1,450,427	11.3
1938	129,824,939	1,381,391	10.6
1939	130,879,718	1,387,897	10.6
1940	131,970,224	1,417,269	10.7
1941	133,202,873	1,397,642	10.5
1942	134,664,924	1,385,187	10.4
1943	136,497,049	1,459,544	10.9
1944	138,083,449	1,411,388	10.6
1945	139,585,518	1,401,719	10.6
1946	141,228,693	1,395,617	10.0
1947	144,002,000	1,445,370	10.0
1948			

Note: Population figures are for July 1st. of each year except the years 1880 and 1890 which are census figures for the year ended May 31.
Death rates for years 1940 through 1948 are based on population excluding armed forces overseas.

Source: Statistical Abstracts of the United States, Department of Commerce, Bureau of the Census.

a long record of reliable vital statistics. For the United States as a whole, however, the reliable vital statistics go back merely to 1900. At that time, the U. S. Mortality Registration Area was quite small, being represented merely by the New England states, New York, New Jersey, Michigan, Indiana and the District of Columbia. Only 30.7 million people were involved or 40.5 per cent of the total population of the United States. Since then the U. S. Registration Area for Deaths has grown slowly but steadily until in 1933, it finally included all of Continental United States.

In the analysis that follows, the data for the U. S. Mortality Registration Area, for Massachusetts and for Boston will be presented and analyzed. Particular attention will be directed toward those diseases which are definitely associated with a defective environment. The progress against these diseases during the past 50 or 60 years will therefore reflect the gains in public health that have resulted in whole or in part from the improvements in sanitation that have occurred during this period.

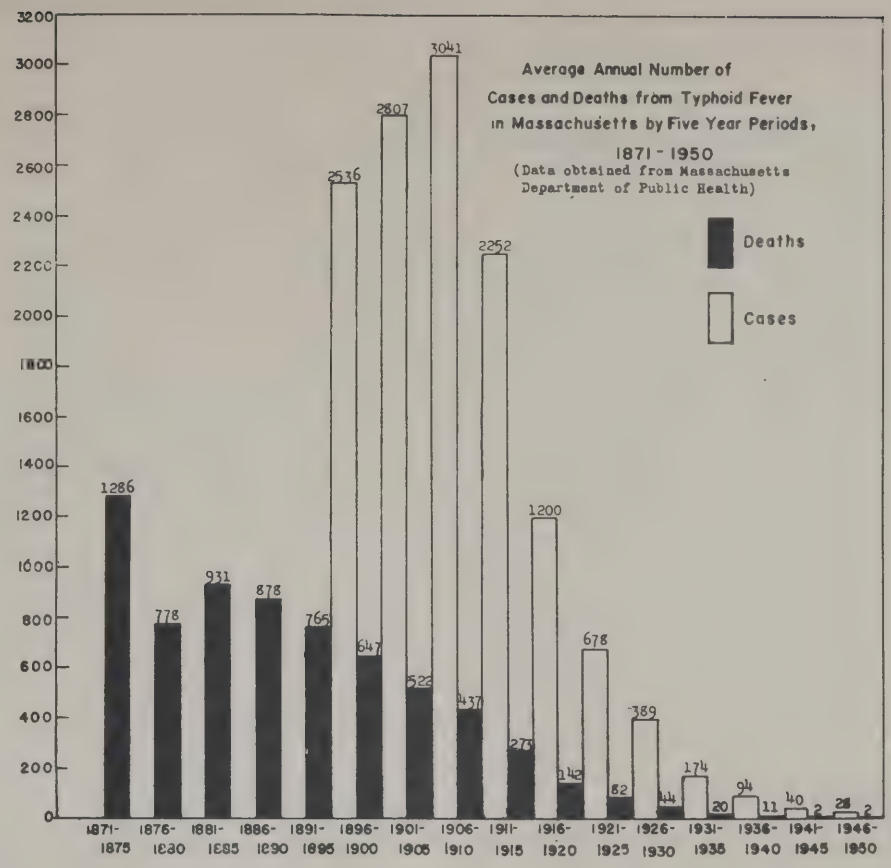


Chart showing average annual number of cases and deaths in five year periods.

General Death Rates

IN 1890 the death rate in the U. S. Death Registration Area was 19.6 per 1,000 population while in 1947 and also in 1948, the last year for which existing data are available, the death rate was exactly 10.0. Thus, the general death rate has been cut in half in 60 years. In 1947, there were 1,445,370 deaths reported in the United States. Had the death rate of 1890 prevailed in 1947, the number of deaths would have been approximately 2,890,000 or almost double. To have almost 1.5 million people alive among the population of 1947 who would have passed off the stage of life prematurely had the insanitary conditions and the lack of scientific knowledge pertaining to disease in 1890 prevailed, is an achievement that can not be evaluated specifically. Who knows whether a human life has been spared that may alter the shape of history during the second half of the twentieth century? Certainly much misery and suffering have been prevented and many children will grow up knowing their parents and receiving their protection in the priceless atmosphere of a home who would have been denied this blessing.

Table 5

Complete Expectation of Life

Period	At Birth		Age 20		Age 40		Age 60	
	M	F	M	F	M	F	M	F
Death Registration States[1] (White Pop.)								
1900–02	48.23	51.08	42.19	43.77	27.74	29.17	14.35	15.23
1909–11	50.23	53.62	42.71	44.88	27.43	29.26	13.98	14.92
1919–21	56.34	58.53	45.60	46.46	29.86	30.94	15.25	15.93
1929–31	59.12	62.67	46.02	48.52	29.22	31.52	14.72	16.05
1939–41	62.81	67.29	47.76	51.38	30.03	33.25	15.05	17.00
1945	64.4	69.5	48.6	52.9	30.6	34.4	15.4	17.8
Massachusetts								
1878–82	41.74	43.50	42.17	42.78	28.86	30.29	15.60	16.91
1890	42.50	44.46	40.66	42.03	27.37	28.76	14.73	15.70

[1] Data for the period 1929–31 to 1945 are for entire continental U. S.; those for 1919–21 to 1920–1929 are for death registration States of 1920; those for earlier years are for the death registration States of 1900.

Historical Statistics of the U. S. 1789–1945.
U. S. Bureau of Census, June 1949.

Average expectancy of life 1890–1948. Not only can public health progress be measured by studying death rates over a long period of time, but also by determining the average expectancy of life at various stages in the life span. The preceding table indicates that the average expectancy of life at birth in the United States in 1890—as measured by the death rates that prevailed in a progressive state like Massachusetts—was approximately 43.0 years. In 1948, the average expectancy of life at birth in continental United States was 67.2 years, and for the white population alone, 68.3 years. For white males, it was 65.5 years and for white females, it was 71.0 years. Thus, the biblical prediction of

the average life span of man, namely three score years and ten, has already been exceeded by the white female population in the United States. There is certainly no reason why this prediction should not be exceeded some day in the immediate future for the entire population, since great discoveries are occurring every year in the fields of chemistry, physics and biology and in their applications to preventive sanitation, preventive hygiene, and preventive and therapeutic medicine.

The progress against premature death has been constant during the period 1890–1950. This can be observed from the data for the expectation of life at birth presented in the previous table. To have added 25 years to the average life span of man in the brief period of 60 years of scientific endeavor is one of man's greatest achievements. The ability to think, to question, to experiment, to discover and to pass on to countless generations the heritage of the past represents a quality that can be attributed only to man on this earth. One may legitimately stand in reverent awe before the greatness and the potential strength of the human mind.

Life expectancy during later age periods. If 25 years have been added to the average life span of man at birth during the past 60 years, the same rate of progress has not been made during the later age periods of life. At age 20, the gain in life expectancy between 1890 and 1950 has been only 10 years; at age 40, it has been only 4 years; and at age 60, it has been only 1 year. In other words, the great progress that has been made in prolonging life has resulted from the control of preventable diseases. In this category are all the diseases that are spread through a defective environment. In this category are all the diseases that have been prevented through improvements in sanitation. Future progress in prolonging life expectancy must come through knowledge that will enable man to prevent senescence and the diseases of old age.

The preceding table demonstrates the specific public health gains that have been made in the United States between 1900 and 1945 at each age group over the entire life span. The data demonstrate once more that the great saving in preventable deaths has occurred primarily in infancy and childhood. Gains have been made in preventing deaths and in prolonging life throughout the entire life span, but the gains in the later adult years have been relatively small when compared with the phenomenal gains made during the early and tender years of life.

Table 6

Death Rates by Age for U.S.A. 1900–1945

Year	Under 1	1–4	5–14	15–24	25–34	35–44	45–54	55–64	65–74	75–84	85 and over
1900	162.4	19.8	3.9	5.9	8.2	10.2	15.0	27.2	56.4	123.3	260.9
1901	141.4	16.9	3.5	5.5	8.0	10.3	15.0	27.8	56.2	124.6	260.8
1902	138.9	16.6	3.3	5.1	7.5	9.6	14.0	25.9	52.9	114.1	235.6
1903	132.6	15.4	3.4	5.2	7.5	9.8	14.3	27.2	55.0	120.8	253.7
1904	139.2	15.9	3.7	5.5	7.8	10.2	15.1	28.5	58.2	126.1	270.0
1905	141.2	15.0	3.4	5.2	7.4	9.8	14.7	27.7	56.2	122.4	261.5
1906	144.8	15.8	3.3	5.3	7.5	9.8	14.5	27.1	55.0	120.4	255.1
1907	138.6	14.7	3.2	5.3	7.5	10.2	15.1	28.6	58.8	128.7	269.1
1908	133.2	14.0	3.0	4.8	6.7	9.0	13.8	26.2	53.8	119.5	248.6
1909	126.7	13.5	2.8	4.4	6.3	8.7	13.3	25.6	53.9	118.4	244.9
1910	131.8	14.0	2.9	4.5	6.5	9.0	13.7	26.2	55.6	122.2	250.3
1911	114.0	11.8	2.7	4.5	6.4	8.9	13.5	25.8	55.0	120.1	246.4
1912	111.1	10.9	2.5	4.3	6.1	8.6	13.4	25.8	54.5	120.2	242.2
1913	114.8	11.9	2.7	4.4	6.2	8.7	13.5	25.5	54.1	117.9	235.9
1914	107.2	10.2	2.5	4.2	6.0	8.5	13.1	25.1	54.1	115.6	231.5
1915	102.4	9.2	2.3	4.1	5.8	8.3	13.1	25.5	55.6	120.1	240.3
1916	105.7	11.1	2.5	4.4	6.2	8.8	13.6	26.5	57.2	123.9	250.4
1917	104.6	10.7	2.6	4.7	6.5	9.0	13.9	26.8	57.3	123.9	245.9
1918	111.7	15.7	4.1	10.7	16.4	13.4	15.2	26.5	55.0	113.0	222.1
1919	91.0	9.3	2.7	5.3	7.5	8.6	12.3	23.1	50.0	107.8	222.2
1920	92.3	9.9	2.6	4.9	6.8	8.1	12.2	23.6	52.5	118.9	248.3
1921	80.6	8.0	2.5	3.9	4.9	6.8	11.2	22.1	49.0	111.2	239.1
1922	77.6	7.4	2.1	3.8	5.0	7.1	11.8	23.2	52.2	117.5	258.1
1923	81.1	8.1	2.1	3.9	5.0	7.3	12.2	23.9	53.3	123.5	279.7
1924	76.8	6.8	2.0	3.8	4.8	7.1	12.1	23.0	51.0	117.2	261.8
1925	75.4	6.4	2.0	3.8	4.8	7.2	12.2	23.3	51.7	119.3	272.3
1926	77.9	7.2	1.9	3.7	4.9	7.4	12.7	24.1	53.8	125.4	279.7
1927	68.8	5.9	1.9	3.5	4.7	7.1	12.0	22.9	51.2	115.9	250.1
1928	73.1	6.5	1.9	3.7	5.0	7.5	12.8	24.2	54.3	125.2	268.3
1929	71.6	6.3	1.9	3.6	5.0	7.3	12.7	24.5	54.0	122.2	254.3
1930	69.0	5.6	1.7	3.3	4.7	6.8	12.2	24.0	51.4	112.7	228.0
1931	64.4	5.3	1.7	3.2	4.5	6.7	12.0	23.6	49.9	110.5	222.8
1932	61.3	4.6	1.5	2.9	4.2	6.3	11.6	23.4	50.0	114.3	233.3
1933	61.3	4.7	1.5	2.7	4.1	6.2	11.4	23.2	49.0	111.3	222.3
1934	66.8	5.1	1.5	2.8	4.1	6.2	11.8	23.5	49.4	114.1	224.8
1935	60.9	4.4	1.5	2.7	4.0	6.2	11.6	23.2	48.7	113.1	224.6
1936	62.9	4.4	1.5	2.8	4.1	6.5	12.1	24.1	50.8	121.7	242.7
1937	61.3	4.2	1.4	2.6	3.9	6.2	11.8	23.5	49.0	117.0	227.2
1938	58.0	3.8	1.2	2.3	3.4	5.6	10.9	22.1	47.1	110.9	212.6
1939	53.7	3.2	1.1	2.1	3.2	5.3	10.7	22.1	47.2	112.5	223.3
1940	54.8	2.9	1.0	2.0	3.1	5.2	10.6	22.0	48.2	110.9	230.1
1941	52.3	2.8	1.0	2.0	2.9	5.0	10.3	21.4	46.6	106.0	218.4
1942	48.0	2.4	0.9	1.9	2.8	4.9	10.1	21.0	45.6	102.3	212.6
1943	43.0	2.6	1.0	2.0	2.8	4.9	10.3	21.5	47.4	108.5	234.6
1944	43.3	2.3	0.9	2.0	2.7	4.7	9.8	20.6	45.5	102.7	223.3
1945	41.4	2.0	0.9	2.0	2.7	4.6	9.7	20.3	44.6	99.5	222.5

Typhoid Fever Death Rates, U. S. Registration Area, 1900–1947. The control of typhoid fever has been one of the outstanding achievements of sanitary science in the United States during the period 1890–1950. The

reasons that brought this miracle to pass have been enumerated earlier in this review. In the 48 years from 1900 to 1947, the death rate in the U. S. Death Registration Area fell from 35.9 to 0.2 per 100,000 population. Had the death rate from typhoid fever in 1900 prevailed in 1947, there would have been approximately 51,800 deaths from this disease instead of the 325 that were reported. The saving represents many precious lives. It represents a saving of approximately 500,000 cases of typhoid fever. It represents the prevention of prolonged and agonizing illness as well as tremendous expense for a great many people. It represents another glorious and brilliant chapter in the applications of science to the promotion of health and well-being of mankind.

Typhoid fever in Massachusetts. The progress against typhoid fever in the United States since 1900 naturally also reflects the progress against this disease in Massachusetts. In 1900, the typhoid fever death rate in Massachusetts was 22.1 per 100,000 population; in 1945, the rate was 0.1. In fact, the average annual death rate from typhoid fever in Massachusetts for the five-year period 1941–1945, was only 0.1 per 100,000 population. However, these low rates did not prevail in Massachusetts before the dawn of modern sanitary science. In the decade from 1861–1869, the average annual death rate from typhoid fever was 83.2; between 1870–1879, it was 67.8; between 1880–1889, it was 46.9; and between 1890–1899, it was 29.6. Under these conditions, typhoid fever was obviously an endemic disease. Unquestionably the purification and disinfection of public water supplies and the pasteurization of milk supplies have been the most significant factors in the control of the gastro-enteric diseases. To be able to travel across this great country, from the Atlantic to the Pacific or from the Great Lakes to the Gulf of Mexico without being exposed to any appreciable degree to typhoid fever in the public water supply or the public milk supply is a sanitary achievement of extraordinary proportions. We have paid a high price to typhoid fever and other gastro-enteric diseases in the sacrifice of countless human lives, but we may say that the important lesson of keeping feces out of our drinking water, and out

Table 7

Deaths from Typhoid and Paratyphoid Fever Number and Rate in the United States Death Registration Area, 1900 to 1947

Year	Population of Death Registration Area	Total Number Deaths	Rate Per 100,000 Population
1900	30,765,618	11,044	35.9
1901	31,370,952	10,127	32.3
1902	32,029,815	10,980	34.3
1903	32,701,083	11,149	34.1
1904	33,345,163	10,557	31.7
1905	34,052,201	9,479	28.1
1906	41,983,419	13,160	32.1
1907	43,016,990	12,670	30.3
1908	46,789,913	11,375	25.3
1909	50,870,518	10,722	22.0
1910	53,831,742	12,673	23.5
1911	59,183,072	12,451	21.0
1912	60,359,974	9,987	16.5
1913	63,200,625	11,323	17.9
1914	65,813,315	10,185	15.5
1915	67,095,681	8,332	12.4
1916	71,349,162	9,510	13.3
1917	74,984,498	10,113	13.5
1918	81,333,675	10,247	12.6
1919	85,166,043	7,860	9.2
1920	87,632,592	6,805	7.8
1921	89,102,434	8,007	9.0
1922	93,866,240	6,981	7.5
1923	97,816,104	6,635	6.8
1924	100,082,062	6,677	6.7
1925	102,951,999	8,287	8.0
1926	104,938,301	6,826	6.5
1927	108,177,568	5,905	5.5
1928	114,258,516	5,620	4.9
1929	116,317,515	4,854	4.2
1930	118,560,800	5,698	4.8
1931	119,421,000	5,382	4.5
1932	120,122,000	4,441	3.7
1933	125,578,763	4,473	3.6
1934	126,373,773	4,237	3.3
1935	127,250,232	3,531	2.8
1936	128,053,180	3,182	2.5
1937	128,824,829	2,743	2.1
1938	129,824,939	2,418	1.9
1939	130,879,718	2,001	1.5
1940	131,970,224	1,443	1.1
1941	133,202,873	1,063	0.8
1942	134,664,924	750	0.6
1943	136,497,049	683	0.5
1944	138,083,449	551	0.4
1945	139,585,518	534	0.4
1946	141,228,693	407	0.3
1947	144,002,000	325	0.2

Note: Population figures are mid-year estimates and are based on census figures. Death rates for years 1940 through 1948 are based on population excluding armed forces overseas.

Source: Statistical Abstract of the United States, Department of Commerce, Bureau of the Census.

of our milk and food supplies has been learned. The problem of the future is to retain the victory that has been won. To this end, man will be compelled to exercise his wisdom and his vigilance constantly.

PART 6

MARCH 1952

ANOTHER HUMAN toll which has been affected tremendously by improvements in sanitation has been the deaths among infants. Many of them died prematurely and hence unnecessarily because of infected water, the use of dirty and infected raw milk, through the lack of refrigeration and plumbing facilities in the home, and through the infections carried by flies. Unquestionably poor and improper feeding and other unsatisfactory hygienic practices played an important role in producing high infant death rates, but it is certain that the gains that have been made against infant mortality have been due to significant improvements in sanitation.

At one time, the incidence of infant deaths was especially high during the summer months when high temperatures, lack of refrigeration, poor milk, unsatisfactory feeding, poor hygiene and swarms of flies combined to make life impossible for a great many infants. This situation exists even today in countries where sanitary progress has not occurred, as in Egypt, India, the Orient, the Balkans, in Mexico and many of the Latin American countries. Today, the summer season in the United States is the healthiest period of the year for infants. Accordingly infant deaths occur more frequently during the winter months. Approximately 75 per cent of all the infant deaths in the United States today occur during the first month of life and are associated with the lack of proper prenatal care or with unsatisfactory obstetrical service. Today, deaths from gastroenteric disease among infants in the United States occur with relative infrequency. Man's most precious crop is now safely harvested and preserved for future and prolonged usefulness.

Unfortunately, reliable infant mortality statistics for the United States or a considerable portion of it go back only to 1915 when the U. S. Birth Registration Area was established. By that time considerable progress had been made in the field of environmental sanitation. It is impossible, therefore, to evaluate satisfactorily the progress that has been made against infant mortality in the United States by studying the record merely from 1915 to 1950. Fortunately, reliable infant mortality statistics are available for Massachusetts since 1851 and it is therefore possible to obtain a more adequate idea of man's progress against the scourge of infant mortality by a review of this longer record.

Table 8

Infant Mortality: Number and Rate in the United States Birth Registration Area 1915 to 1947

Year	Total Number Infant Deaths*	Total Number Live Births	Rate per 1,000 Live Births
1915	148,561	776,304	99.9
1916	164,660	818,983	101.0
1917	171,024	1,353,792	93.8
1918	193,855	1,363,649	100.9
1919	161,621	1.373,438	86.6
1920	174,710	1,508,874	85.8
1921	160,011	1,714,261	75.6
1922	158,560	1,774,911	76.2
1923	166,274	1,792,646	77.1
1924	161,404	1,930,614	70.8
1925	161,961	1,878,880	71.7
1926	163,343	1,856,068	73.3
1927	147,134	2,137,836	64.6
1928	155,858	2,233,149	68.7
1929	148,886	2,169,920	67.6
1930	145,374	2,203,958	64.6
1931	132,874	2,112,760	61.6
1932	121,267	2,074,042	57.6
1933	120,887	2,081,232	58.1
1934	130,185	2,167,636	60.1
1935	120,138	2,155,105	55.7
1936	122,535	2,144,790	57.1
1937	119,931	2,203,337	54.4
1938	116,702	2,286,962	51.0
1939	108,846	2,265,588	48.0
1940	110,984	2,360,399	47.0
1941	113,949	2,513,427	45.3
1942	113,492	2,808,996	40.4
1943	118,484	2,934,860	40.4
1944	111,127	2,794,800	39.8
1945	104,684	2,735,456	38.3
1946	111,063	3,288,672	33.8
1947	119,173	3,699,940	32.2

* Total Number of Deaths under 1 year of age, exclusive of stillbirths.

Source: Statistical Abstract of the United States, Department of Commerce, Bureau of the Census.

Table 8 indicates that in 1915, the infant mortality rate for the U. S. Birth Registration Area was 100. This means that 10 out of every 100 live babies died before reaching the age of one year. In 1948, the infant death rate in the more expanded U. S. Birth Registration Area, which included all of continental United States, was only 30. In other words, only 3 out of every 100 live babies died before reaching the age of one year. While this rate must still be regarded as too high, the improvement over 1915 and over earlier years is so great that we may take legitimate pride and satisfaction over the progress that has been made.

Infant mortality in Massachusetts, 1851–1948. Table 9 is a record of the infant mortality in Massachusetts for almost a century. The highest infant death rate recorded occurred in 1872 when it reached 194.1 per 1000 live births. The lowest rate occurred in 1948 when it reached 26.4 per 1000 live births. In 1890, when the Massachusetts Public Health Association was founded, the rate was 166.6.

Table 9

Infant Mortality, Total Number Live Births, Total Number Deaths under One Year and Death Rate per 1,000 Live Births for Massachusetts, 1851–1948

Year	No. Live Births	No. Deaths under 1 yr.	Death Rate per 1,000 Live Births	Year	No. Live Births	No. Deaths under 1 yr.	Death Rate per 1,000 Live Births
1851	28,661	3,800	132.5	1901	71,976	9,952	138.3
1852	29,802	3,750	125.8	1902	72,219	10,075	139.5
1853	30,920	4,175	135.0	1903	73,584	10,269	138.3
1854	31,997	4,188	130.9	1904	75,014	9,992	133.2
1855	32,845	4,442	135.2	1905	75,022	10,519	140.2
1856	34,445	4,226	122.7	1906	80,237	11,106	138.4
1857	35,320	4,160	117.8	1907	85,001	11,293	132.9
1858	34,491	4,197	121.7	1908	86,911	11,606	133.5
1859	35,422	4,175	130.0	1909	84,039	10,693	127.2
1860	36,051	4,821	133.7	1910	86,539	11,499	132.9
1861	35,445	5,167	145.8	1911	88,327	10,543	119.4
1862	32,275	4,216	130.6	1912	89,882	10,472	116.5
1863	30,314	4,545	149.9	1913	91,644	10,086	110.1
1864	30,449	4,693	154.1	1914	93,399	9,894	105.9
1865	30,249	4,869	147.2	1915	93,155	9,490	101.9
1866	34,085	4,699	137.9	1916	93,487	9,334	99.8
1867	35,062	4,763	135.8	1917	95,731	9,325	97.4
1868	36,193	5,421	149.8	1918	95,607	10,820	113.2
1869	36,141	5,368	148.5	1919	87,827	7,769	88.5
1870	38,259	6,206	162.2	1920	91,859	8,382	91.2
1871	39,791	5,996	150.7	1921	92,245	7,005	75.9
1872	43,235	8,390	194.1	1922	87,636	7,129	81.3
1873	44,481	7,911	177.8	1923	89,210	6,968	78.1
1874	45,631	7,489	164.1	1924	91,463	6,191	67.7
1875	43,996	7,712	175.3	1925	86,014	6,294	73.1
1876	42,149	6,700	158.4	1926	83,502	6,130	73.4
1877	41,850	6,343	151.5	1927	82,273	5,320	64.7
1878	41,238	6,189	150.1	1928	79,054	5,118	64.7
1879	40,295	5,805	145.2	1929	74,122	4,592	62.0
1880	44,217	7,190	162.6	1930	73,690	4,440	60.3
1881	45,220	7,389	163.4	1931	69,385	3,803	54.8
1882	45,670	7,438	162.9	1932	65,518	3,635	53.1
1883	47,285	7,511	158.8	1933	63,457	3,294	51.9
1884	48,615	7,735	159.1	1934	63,767	3,136	49.2
1885	48,790	7,626	156.3	1935	62,416	3,014	48.3
1886	50,788	7,848	154.5	1936	61,184	2,854	46.6
1887	53,174	8,514	160.1	1937	61,272	2,684	43.8
1888	54,893	8,870	161.6	1938	62,382	2,439	39.1
1889	57,075	9,105	159.5	1939	62,575	2,238	37.4
1890	57,777	9,625	166.6	1940	65,369	2,450	37.5
1891	63,004	10,186	161.7	1941	70,228	2,480	35.3
1892	65,824	10,649	161.7	1942	83,371	2,651	31.8
1893	67,192	10,990	163.6	1943	85,743	2,939	34.3
1894	66,936	10,899	162.8	1944	78,140	2,582	33.0
1895	67,545	10,564	156.4	1945	76,455	2,433	31.8
1896	72,343	11,765	157.8	1946	96,903	2,996	30.9
1897	63,205	10,751	146.9	1947	106,690	3,021	28.3
1898	73,110	11,012	150.6	1948	98,933	2,614	26.4
1899	70,457	10,532	149.5				
1900	73,386	11,500	156.7				

Even at the turn of the twentieth century, in 1900, the rate was 156.7. Since then, however, there has been steady and consistent progress against infant mortality. Progress against infant mortality has coincided with progress in sanitation and the two phenomena are definitely and intimately related to each other.

The progress against infant mortality in Massachusetts masks some unbelievably high infant mortality rates which prevailed at one time in certain industrial communities in the Commonwealth where poverty and ignorance combined with lack of sanitation to produce infant death rates as high as 250 per 1000 live

Table 10

Diarrhea and Enteritis (under 2 Years of Age), Total Deaths and Death Rate per 100,000 Population for Massachusetts 1899–1948

Year	No. Deaths	Death Rate	Year	No. Deaths	Death Rate
1899		77.8	1925	684	16.5
1900		93.8	1926	757	18.0
1901	2705	94.9	1927	582	13.9
1902	2629	91.0	1928	520	12.3
1903	2469	84.3	1929	394	9.3
1904	2297	77.3			
			1930	410	9.6
1905	2617	86.8	1931	275	6.4
1906	2525	81.7	1932	299	5.3
1907	2696	85.3	1933	161	3.7
1908	2691	83.2	1934	194	4.5
1909	2855	86.3			
			1935	219	5.0
1910	3744	110.8	1936	153	3.5
1911	3275	95.0	1937	124	2.8
1912	3180	90.5	1938	122	2.8
1913	2958	82.7	1939	90	2.0
1914	2843	78.0			
			1940	127	2.9
1915	2532	68.7	1941	167	3.9
1916	2391	63.3	1942	112	2.6
1917	2502	65.1	1943	189	4.3
1918	2646	67.7	1944	107	2.5
1919	1493	38.9			
			1945	118	2.6
1920	1667	43.3	1946	163	3.6
1921	1332	34.3	1947	157	3.4
1922	1086	27.6	1948	98	2.1
1923	867	21.8			
1924	772	19.3			

births. Even in enlightened Boston the infant mortality rate between 1890 and 1894 was 146.5 per 1000 live births. As recently as 1920, the infant death rate was 100.3; but in 1949, it had receded to 25.8. Thus from 1890 to 1949 there had been a reduction of 85 per cent in the infant mortality rate of this city.

Diarrhea and enteritis

ONE OF THE principal reasons for the progress that has been made against infant mortality has been the prevention of deaths from gastro-enteric infections. The reasons therefore have already been enumerated. Gastro-enteric infections affected not only infants but also many children during the second year of life and beyond. Since the data for deaths from diarrhea and enteritis under 2 for Boston and Massachusetts are available over a longer period of time than for the U. S. Death Registration Area, they are being used in this evaluation in preference to the more limited statistics for the country as a whole.

It may be observed from Table 10 that great progress has been made in Massachusetts between 1900 and 1948 against deaths due to diarrhea and enteritis under 2. In 1900, the death rate from this cause per 100,000 population was 93.8; in 1948, it had receded to 2.1, thus showing a reduction of almost 98 per cent. A review of the record for the entire period shows that the maximum rate of 110.8 occurred in 1910. While the death rate from diarrhea and enteritis under 2 in Massachusetts receded steadily since 1910, the decline seemed to gain momentum in 1919. By 1929, it was under 10 and since 1933. it has been under 5. Even the depression years of 1931, 1932 and 1933 did not alter the downward trend in the death rate from this cause. Sanitation had arrived and regardless of economic conditions these gains were not sacrificed.

In Boston, the record was similar except that the death rates from diarrhea and enteritis under 2 were higher. Thus between 1890 and 1894, the death rate from this cause averaged 126 per year while in 1900, the rate was 109. As recently as 1911, the death rate from this cause was 106.8 per 100,00 population. Boston, however, has always been a great medical center and deaths during the years under consideration were not allocated for residence. Hence the death rate for diarrhea and enteritis under 2 for Boston during these years was unquestionably inflated. Nevertheless, the deaths from diarrhea and enteritis under 2 among Boston residents during this period were known to be high. In 1949, however, when all deaths occurring in Boston were allocated by residence, there were only 2 deaths from diarrhea and enteritis under 2. This was equivalent to a death rate of only 0.3 per 100,000 population. What a brilliant record of sanitary achievement!

Diphtheria and Scarlet Fever Death Rates, U. S. Registration Area, 1900–1947. Another outstanding chapter in public health progress that is related to sanitary achievement is found in the gains against diphtheria and scarlet fever. In the early years between 1890 and 1950 these two diseases were frequently milk-borne. The introduction of pasteurization on a universal basis in this country, even though progress toward this goal seemed distressingly slow, has resulted in the elimination of milk-borne epidemics of diphtheria, scarlet fever and septic sore throat. While much of this progress has been due to advances in medicine, bacteriology and immunology, the sanitarian has also contributed significantly to this important achievement.

During the period 1900 to 1947, the death rate from diphtheria in the U. S. Death Registration Area receded steadily from 43.3 per 100,000 population in 1900 to 0.6 in 1947. During the same period the death rate from scarlet fever receded from a maximum of 13.1 per 100,000 population occurring in 1901, to a minimum of 0.1 per 100,000 population occurring in 1947. One who has never observed a serious case of diphtheria or who is unfamiliar with the significant sequelae that frequently followed in the wake of scarlet fever can never fully appreciate the gains

in human welfare that have resulted from the virtual control of these two diseases.

Diphtheria and scarlet fever in Massachusetts. The record of achievement against diphtheria and scarlet fever cannot be appraised correctly from a review of the statistics for the U. S. Death Registration Area for 1900–1947. It is necessary to study the record of these two diseases over a much longer period of time. Such information is available in the vital records of Massachusetts. The death rates for diphtheria are available since 1861 and those for scarlet fever, since 1870. The diphtheria record shows that during the period 1861–1948 the highest death rate occurred in 1876 when it reached 196.4 per 100,000 population. In fact, the death rate from diphtheria between 1875 and 1881 was incredibly high. The successive rates by years in deaths per 100,000 population were 113.8, 196.4, 186.6, 145.5, 130.6, 134.3 and 131.4. A rate of 182.4 had prevailed in 1863 and 158.7 in 1864, but except for the tremendous epidemic years from 1875–1881, the rates fluctuated mostly between 50 and 100 per 100,000 population. In 1889, the rate reached 101.7 and from 1890–1894, it averaged around 64 per 100,000 population. Even in 1900, the death rate was as high as 52.8 per 100,000 population. Since then, however, it has receded slowly but steadily to approximately 0.3 per 100,000 population at the present time.

Scarlet fever was likewise a great killer in Massachusetts up to 1895. Since then, it has receded significantly as an important cause of death. The highest death rate since 1870 occurred in 1875, when it reached 101.9 per 100,000 population. From 1870–1879, the death rate from scarlet fever averaged 65 per 100,000 population per year. Between 1880 and 1889, the average annual death rate was 24.3 and between 1890 and 1899, it was 16.5 Since the turn of the century, the rates have diminished steadily until it attained the lowest value on record in 1948, namely, 0.02 per 100,000 population. In that year, there was only one death from scarlet fever in all of Massachusetts.

Table 11

Deaths from Diphtheria (and Group): Number and Rate in the United States Death Registration Area, 1900 to 1947

Year	Population of Death Registration Area	Total Number Deaths	Rate Per 100,000 Population
1900	30,765,618	13,314	43.3
1901	31,370,952	10,667	34.0
1902	32,029,815	9,859	30.8
1903	32,701,083	10,363	31.7
1904	33,345,163	9,444	28.3
1905	34,052,201	8,039	23.8
1906	41,983,419	10,793	26.3
1907	43,016,990	10,154	24.3
1908	46,789,913	10,052	22.3
1909	50,870,518	10,358	21.2
1910	53,831,742	11,521	21.4
1911	59,183,071	11,174	18.9
1912	60,359,974	11,013	18.2
1913	63,200,625	11,920	18.9
1914	65,813,315	11,786	17.9
1915	67,095,681	10,544	15.7
1916	71,349,162	10,367	14.5
1917	74,984,498	12,453	16.6
1918	81,333,675	11,294	13.9
1919	85,166,043	12,551	14.7
1920	87,632,592	13,395	15.3
1921	89,102,434	15,683	17.7
1922	93,866,240	13,659	14.6
1923	97,816,104	11,733	12.1
1924	100,082,062	9,316	9.4
1925	102,951,999	8,058	7.8
1926	104,938,301	7,856	7.5
1927	108,177,568	8,426	7.8
1928	114,258,516	8,263	7.2
1929	116,317,515	7,685	6.6
1930	118,560,800	5,822	4.9
1931	119,421,000	5,738	4.8
1932	120,122,000	5,418	4.5
1933	125,578,763	4,937	3.9
1934	126,373,773	4,159	3.3
1935	127,250,232	3,901	3.1
1936	128,053,180	3,065	2.4
1937	128,824,829	2,637	2.0
1938	129,824,939	2,556	2.0
1939	130,879,718	1,997	1.5
1940	131,970,224	1,457	1.1
1941	133,202,873	1,333	1.0
1942	134,664,924	1,273	1.0
1943	136,497,049	1,196	0.9
1944	138,083,449	1,145	0.9
1945	139,585,518	1,598	1.2
1946	141,228,693	1,259	0.9
1947	144,002,000	799	0.6
1948			

Note: Population figures are mid-year estimates.
Death rates for the years 1940 through 1948 are based on population excluding armed forces overseas.

Source: Statistical Abstract of the United States, Department of Commerce, Bureau of the Census.

PART 7

APRIL, 1952

TUBERCULOSIS is another disease against which amazing progress has been made. It is questionable whether the present generation can fully appreciate the magnitude of the scourge which tuberculosis represented. Called the Captain of Death, it took a heavy toll in human life every year. Hardly a family was left untouched by this disease. Since the highest death rates occurred in the young adult age groups, the social significance of this disease was especially great. Between 1861 and 1882 when Robert Koch discovered that tuberculosis was caused by the tubercle bacillus, the death rate from respiratory tuberculosis alone ranged in Massachusetts between 297.4 and 375.7 per 100,000 population. The highest rate occurred in 1864 and the lowest in 1879. Only once during this period was the death rate from respiratory tuberculosis under 300 per 100,000. Non-pulmonary tuberculosis was likewise a very important cause of death and the death rate from tuberculosis, all forms, ranged between 350 and 400 per 100,000 population. Since there were probably 10 cases for every death, the appalling incidence and toll of this disease may be more fully appreciated.

Reasons for decline in tuberculosis mortality. Strange as it may seem, the marked decline in the death rate from tuberculosis began with the discovery of the tubercle bacillus and occurred long before the organization of tuberculosis clinics or the establishment of tuberculosis hospitals and sanatoria on a substantial scale or the development of mass X-ray examinations for detecting tuberculosis in the population. It were as though the tubercle bacillus, on discovery in 1882, admitted that "the jig was up" and decided to surrender in the life and death struggle for survival with man. Certainly, the marked reduction in the death rate from tuberculosis began even before the development of community health education programs and before the wonderful discoveries in nutrition and antibiotics were made. We must, therefore, look to other possible reasons for a reduction in tuberculosis mortality that was initiated in the middle eighties of the nineteenth century.

One possible factor that must not be overlooked is the fact that the tubercle bacillus may have experi-

Table 12

Deaths from Scarlet Fever: Number and Rate in the United States Death Registration Area, 1900 to 1947

Year	Population of Death Registration Area	Total Number Deaths	Rate Per 100,000 Population
1900	30,765,618	3,135	10.2
1901	31,370,952	4,113	13.1
1902	32,029,815	4,041	12.6
1903	32,701,083	3,991	9.8
1904	33,345,163	3,610	11.0
1905	34,052,201	2,284	6.8
1906	41,983,419	3,227	7.9
1907	43,016,990	4,309	10.3
1908	46,789,913	5,577	12.4
1909	50,870,518	5,781	11.9
1910	53,831,742	6,255	11.6
1911	59,183,071	5,243	8.9
1912	60,359,974	4,038	6.7
1913	63,200,625	5,498	8.7
1914	65,813,315	4,340	6.6
1915	67,095,681	2,419	3.6
1916	71,349,162	2,355	3.3
1917	74,894,498	3,141	4.2
1918	81,333,675	2,486	3.1
1919	85,166,043	2,383	2.8
1920	87,632,592	4,004	4.6
1921	89,102,434	4,718	5.3
1922	93,866,240	3,256	3.5
1923	97,816,104	3,440	3.5
1924	100,082,062	3,122	3.1
1925	102,951,999	2,762	2.7
1926	104,938,301	2,662	2.5
1927	108,177,568	2,440	2.3
1928	114,258,516	2,229	2.0
1929	116,317,515	2,468	2.1
1930	118,560,800	2,279	1.9
1931	119,421,000	2,650	2.2
1932	120,122,000	2,577	2.1
1933	125,578,763	2,564	2.0
1934	126,373,773	2,524	2.0
1935	127,250,232	2,718	2.1
1936	128,053,180	2,493	1.9
1937	128,824,829	1,824	1.4
1938	129,824,939	1,206	0.9
1939	130,879,718	853	0.7
1940	131,970,224	668	0.5
1941	133,202,873	403	0.3
1942	134,664,924	447	0.3
1943	136,497,049	451	0.3
1944	138,083,449	422	0.3
1945	139,585,518	303	0.2
1946	141,228,693	198	0.1
1947	144,002,000	107	0.1
1948			

Note: Population figures are mid-year estimates and are based on census figures.
Death rates for the years 1940 through 1948 are based on population excluding armed forces overseas.

Source: Statistical Abstract of the United States, Department of Commerce, Bureau of the Census.

enced some natural change in virulence. The tubercle bacillus is a living organism and it is possible that a change in the parasite-host relationship between it and man could have taken place which could account for the reduction in the toll from tuberculosis. However this explanation of the gains against tuberculosis is unlikely, for the disease has continued to take a high toll in certain segments in the population of the United States, while in other areas of the world, in certain Latin American countries and in China for example, the mortality from tuberculosis has continued to be excessive. We must look therefore to other causes for the excellent progress against this disease.

The initiation of the downward trend in tuberculosis mortality coincided with the origin and evolution of modern sanitation. We have observed earlier in this review, that the purification of water supplies, the sanitary disposal of human excrement and the improvement in the sanitary production of milk, including pasteurization, all began on a substantial scale, especially in Massachusetts, during the last 10 or 15 years of the nineteenth century. Hiram F. Mills had called attention to the fact that the purification of the public water supply in Lawrence, Mass., by slow sand filtration in 1893 had resulted not only in the reduction of the morbidity and mortality from typhoid fever and other intestinal diseases, but there had occurred simultaneously and for some inexplicable reason a reduction in mortality from certain respiratory diseases, including tuberculosis. J. J. Reincke, in Hamburg, Germany, studying the effects of slow sand filtration on the water supply of that community, following the tragic epidemic of cholera in 1892, had made similar observations independently and also came to the conclusion, as did Mills, that water purification affects the death rate from tuberculosis as well as typhoid fever and other intestinal diseases.

It seems logical that since disease represents the ascendancy of the parasite over the vital resistance of the host, anything that helps substantially to maintain the vital resistance of the host is an imporant factor in preventing certain diseases. Since typhoid fever was a terribly debilitating disease which undermined resistance and often paved the way to tuberculosis, it follows that anything that prevented typhoid fever prevented a drain on one's vital resistance and hence was a significant factor in the control of a disease like tuberculosis which was related so intimately to vital resistance. The ex-

Table 13

Deaths from Tuberculosis (All Forms): Number and Rate in the United States Death Registration Area, 1900 to 1947

Year	Population of Death Registration Area	Total Number Deaths	Rate Per 100,000 Population
1900	30,765,618	62,096	201.9
1901	31,370,952	61,767	196.9
1902	32,029,815	59,083	184.5
1903	32,701,083	61,640	188.5
1904	33,345,163	66,921	199.7
1905	34,052,201	65,352	193.6
1906	41,983,419	75,512	184.2
1907	43,016,990	76,640	183.6
1908	46,789,913	78,289	173.9
1909	50,870,518	81,720	167.5
1910	53,831,742	86,309	160.3
1911	59,183,071	94,205	159.1
1912	60,359,974	90,360	149.7
1913	63,200,625	93,421	147.9
1914	65,813,315	96,903	147.2
1915	67,095,681	98,194	146.4
1916	71,349,162	101,396	142.1
1917	74,984,498	110,285	147.0
1918	81,333,675	122,249	150.3
1919	85,166,043	106,985	125.7
1920	87,632,592	99,916	114.0
1921	89,102,434	88,135	99.4
1922	93,866,240	90,452	97.0
1923	97,816,104	90,732	93.5
1924	100,082,062	89,724	90.4
1925	102,951,999	89,268	86.7
1926	104,938,301	91,586	87.1
1927	108,177,568	87,567	81.0
1928	114,258,516	90,659	79.3
1929	116,317,515	88,352	76.0
1930	118,560,800	84,741	71.5
1931	119,421,000	81,395	68.2
1932	120,122,000	75,509	62.8
1933	125,578,763	74,842	59.5
1934	126,373,773	71,609	56.6
1935	127,250,232	70,080	55.0
1936	128,053,180	71,527	55.6
1937	128,824,829	69,324	53.6
1938	129,824,939	63,735	49.0
1939	130,879,718	61,609	47.2
1940	131,970,224	60,428	45.9
1941	133,202,873	59,400	44.5
1942	134,664,924	57,690	43.1
1943	136,497,049	57,005	42.6
1944	138,083,449	54,731	41.3
1945	139,585,518	52,916	40.1
1946	141,228,693	50,911	36.4
1947	144,002,000	48,064	33.5
1948			

Note: Population figures are mid-year estimates and are based on census figures.
Death rates for the years 1940 through 1948 are based on population excluding armed forces overseas.

Source: Statistical Abstract of the United States, Department of Commerce, Bureau of the Census.

perience of many Europeans in World Wars I and II supports the thesis that deprivation, hardships and reduction in vital resistance favor a resurgence in the incidence and mortality from tuberculosis. On the other hand, the United States which did not suffer deprivations and hardships in the two World Wars did not witness an increase in incidence or mortality from tuberculosis.

There can be little doubt that non-pulmonary tuberculosis was spread through the use of tuberculous raw milk. In 1900, non-pulmonary tuberculosis in Massachusetts was responsible for 27 per cent of the death rate from tuberculosis, all forms, which stood at 253.3 per 100,000 population. In 1948, this proportion was diminished to 6 per cent of the death rate from tuberculosis, all forms, which stood at 29.4 per 100,000 population. During this period public milk supplies were increasingly sanitated and pasteurized and tuberculous cattle were removed from dairy herds and slaughtered.

Non-pulmonary tuberculosis is relatively rare in the United States today, especially in those areas where the public milk supply is safeguarded through pasteurization. There is little doubt that much of the credit for this improvement must be attributed to improved sanitation. If we take into account all of the progress in environmental sanitation coupled with the tremendous improvements in the standard of living in the United States, including the reduction in the working day and working week, the introduction of vacations with pay, the improvement in housing facilities, the safeguarding of food supplies and the general education of the population in the principles of healthy living, it is possible to conclude that sanitation coupled with social progress have been largely responsible for one of the greatest miracles of the past 60 years—the control of tuberculosis.

In the United States as a whole the tuberculosis death rate has declined from 201.9 per 100,000 population in 1900 to 30 per 100,000 population in 1948, a reduction of 85 per cent—in the first half of the twentieth century alone. The reduction would be even greater if earlier data were available. This declnie was steady and continuous throughout this period despite depressions and wars. The rate of the decline became somewhat accelerated following the serious epidemic of influenza-pneumonia in 1918. Doubtless this disease carried off many individuals who would normally have died from tuberculosis. It is impossible to escape the conclusion however that progress in sanitation with the resulting control of the gastro-enteric and insect-borne diseases, has played a fundamental role in the control of tuberculosis. In some American states the death rate from tuberculosis has already been reduced to less than 10 per 100,000 population per year. Tuberculosis as a scourge of man in the United States is a vanishing disease.

CONCLUSION

MAY, 1952

ARE the tasks of environmental sanitation completed? — With such a wonderful record of achievement in the field of sanitation between 1890 and 1950, it is only proper to inquire whether this chapter in man's book of important accomplishments is not completed. Certainly it is true that there can be no relaxation of man's effective control over his environment if he is to continue to enjoy the safety, the protection, the comforts he has gained at such great cost. The water, milk and food supplies must be safeguarded constantly and sewers must function effectively. Similarly, insect vectors of disease must be subjugated constantly if the health and welfare of entire populations are to be safeguarded. The mere interruption of the constant flow of electricity or a break in the constant availability of chlorine for disinfecting the public water supply may lead promptly to epidemic conditions and incredible suffering. The failure to remove garbage from a municipality for some time because of strikes or other causes may reestablish overnight the incredible insanitary conditions of the nineteenth century.

The maintenance of organized community living and the safety and comforts it provides are dependent on a delicate balance of cooperative efforts that have their roots in modern sanitation. When these were destroyed by war in a large and populous community like Naples, Italy, over 1,000,000 people were confronted overnight with the hazards of typhus fever and gastro-enteric infections of epidemic proportions. When London was being bombed relentlessly by the Germans during the summer and fall of 1940 and sewage was mingling freely with the drinking water in burst mains prior to repair, it was through the practice of the principles of sanitation that the people were spared the ravages of water-borne diseases.

Even New York in peacetime was confronted in 1949 and 1950 with the necessity of conserving water from a dwindling supply in order to provide for the health and safety of that populous community. We may conclude therefore that the world will always have to depend on sanitation in order to continue to enjoy the public health protection and comforts that have been gained from this source. Unfortunately most people now take these gains for granted. They do not realize how dependent we are for health, safety and comfort on their uninterrupted continuance.

Travel emphasizes the need of sanitation. — Another reason for continued emphasis on sanitation is the extensive movement of the population from one place to another especially by modern methods of transportation. Man is a restless and curious animal. He always wants to see what is on the other side of the hill. As he has developed his mastery over time and space and as he has improved his economic status, he has moved about the earth to an increasing degree even during periods of peace.

World War II, because of its scope, witnessed mass migrations of men to all areas: — to the tropics, to the arctic regions and to the areas in between. In 1947, Ross A. McFarland[2] stated that "it is estimated that seven million people in the United States, of whom about one million were international travelers, made some 15 or 16 million trips by air in 1947. At the same time, approximately five million people used air transportation in other countries and transoceanic steamship passengers numbered almost two million." Today, any area of the world is within easy reach by air from the great centers

of population within 60 hours.

Thus the diseases and insect vectors of the tropical and subtropical regions may be carried swiftly and surely to almost any other area of the world. In 1944, the U. S. Public Health Service, in routine inspections of air transports arriving at Miami, recovered 81 live mosquitoes and 1371 dead ones from approximately 9300 planes. In 1947, the proportion of insect recoveries to planes had changed very little. Similar observations have been reported from African and South American inspection stations. The introduction of the dreaded malarial mosquito, Anopheles gambiae, in Brazil from Africa through Natal in 1930 by means of modern methods of rapid transportation, in this case, through a French destroyer arriving from West Africa, is a graphic illustration of the public health hazards associated with modern transportation and our utter dependence on effective sanitary precautions for our continued safety. In consequence, planes arriving at international airports are disinfested en route as well as on the loading platform with aerosol bombs or by means of sprays containing pyrethrum and DDT.

Other public health hazards also exist such as those surrounding the use of water, dairy products and foods, the disposal of human excreta, the sudden shifting from one pressure to another and from arctic to tropical temperatures and vice versa.

World sanitary problems still require serious attention. — In discussing the question whether the problems of environmental sanitation have been solved completely, Abel Wolman[2] states that even in the United States "millions of the citizens still live without even primitive facilities for water supply or sewage disposal or both." He states that 2.5 billion dollars are necessary for water supply development in the United States today and more than five billion dollars for sewerage and sewage and industrial waste disposal programs.

As for housing, the slum dwelling is still all too prevalent even in our richest and proudest cities. In the rest of the world outside the United States and a few other progressive areas, where almost two billion people dwell, the great killers and the great debilitators are still the enteric diseases, the insect and rodent-borne diseases and the diseases resulting from overcrowding and nutritional deficiencies.

According to Gordon M. Fair[8], about 70 per cent of the urban communities in the United States or 14,000 in number, in 1950, have been provided with water supply systems. These systems serve approximately 85 million people. Almost as great a population, approximately 70 million in number, have been connected to public sewerage systems and 70 per cent of these people discharge their sewered wastes to 5,500 sewage treatment plants. Nevertheless there are 6,000 communities in the United States that still do not have a public water supply and more than 9,000 communities that still lack sewerage systems. In the rural areas, it is estimated that 33 million people still do not possess facilities for excreta disposal even of the most elementary kind. Some of the largest cities in the United States are supplied with water that receives no treatment other than chlorination while other large communities draw their water supplies from sources that are too heavily polluted with sewage and trade wastes.

Many of the older communities are burdened with antiquated and inadequate combined sewers which overflow into relief sewers that foul the beaches that are often available for recreational purposes. The problem of reclaiming our national streams, lakes and estuaries from gross pollution with sewage and trade wastes has only really just begun with the enactment by Congress of a national stream pollution control act.

Furthermore, the importance of water as a natural resource and the significance of maintaining the ground water table at a suitable level in order to prevent creating desert conditions are being recognized to an ever-increasing degree, especially in those areas where water is scarce. These conditions indicate that there is still ample room for profitable endeavor in the field of sanitation even in the United States today. When one considers the vastness of the untilled fields of sanitation in most of the world, one realizes how much needs to be accomplished in these areas merely to reach the level of attainment in sanitation which the United States enjoys at the present time.

Certainly there is also a vast field of useful endeavor beckoning for attention in the safe and sanitary handling, transportation, storage, preparation and dispensing of milk and foods in the world today. In many instances, even in the largest and most progressive cities in the United States, the insanitary conditions associated with the processing of foods borders on the primitive. Despite health department inspection and supervision, one may find the primitive, insanitary practices of the orient, the Near East, the Balkans and the Slavic countries in use in certain sections of the large cities of the United States in the handling and processing of foods. Similarly, the cleansing and sterilization of eating and drinking utensils leaves much to be desired despite food handler training programs, sanitary codes, health department inspections and bacterial analyses of swab rinse samples. Accordingly the reciprocal commerce in human saliva that goes on must be enormous and unquestionably plays a role, though an indeterminate one, in the spread of respiratory infections. Wolman[2] concludes that "the handling of milk and food for the bulk of the population of the world is in a medieval state."

Many other problems of environmental sanitation await adequate professional and community consideration. The problem of atmospheric pollution with dusts, toxic gases, smoke and foul odors often becomes acute in almost every industrial community. The smoke problems of Pittsburgh and St. Louis were notoriously bad. More recently, on October 27, 1948, the experience of Donora[9], Pennsylvania, a small community of 14,000 people, located in a valley on the Monongahela River about 40 miles southeast of Pittsburgh, aroused the people of the United States to a consciousness of the real and potential hazards of living in an atmosphere of smog. This unfavorable condition of the atmosphere lasted for five days. In consequence, 5,910 persons became ill and 20 persons died. What the physiological effects are of living in

an atmosphere of smog month after month and year after year even though the acute conditions of Donora never develop, have not been determined. Certainly intelligent people will never *choose* to live in such atmospheres nor to bring up children under such unfavorable conditions.

The field of industrial hygiene and sanitation has only just been scratched despite some fundamental and extensive work that has been done in certain areas already. Dusts, toxic fumes and gases, unfavorable temperatures and humidities, poor lighting, excess fatigue, excessive noise, unsatisfactory toilet and drinking facilities, poor facilities for hand and body hygiene, inadequate protection against accidents, unsatisfactory lunchroom facilities — these are some of the problems of environmental sanitation associated with business and industry that will have to be solved more effectively someday.

In the community of the future better facilities for decent and comfortable housing of the population must be provided. Slums will have to be eliminated. Parks, playgrounds and suitable places for recreation will have to be provided. The sanitary condition of the streets must be improved and refuse, including garbage, must be removed frequently and disposed of in a sanitary manner. Greater efforts must be made to study and reduce the tremendous toll we pay annually in the United States in the form of deaths and injuries from accidents occurring on the highways and in the homes. Indeed the field of environmental sanitation is still a tremendously fertile field for profitable and creative human endeavor and promises to provide ample opportunity for those who are equipped to serve for many generations to come.

Sanitation and the aging population. — There is another important and fundamental reason why environmental sanitation will receive greater emphasis in the future rather than less. The fact that the enteric and insect-borne diseases have been brought under control to an astonishing degree in the United States through the control of certain aspects of environmental sanitation will naturally direct the interest and energies of man to improve other aspects of his environment. Furthermore, the tremendous public health gains which have been achieved in the past 60 or 70 years have resulted in a population with a large proportion of the people in the older age groups. Such people are interested in comfort and convenience and they will demand community environments that will be comfortable, pleasant and attractive and that cater to their needs.

In 1890, 17 per cent of the population of the United States was 45 years of age or over. In 1900, this ratio was increased to 17.8 per cent. In 1940, 26.5 per cent of the population was 45 years of age or older. In 1950, this ratio was about 28 per cent. It is estimated that by 1960, this group will represent 31.7 per cent of the population and that by the year 2000, it will represent 40 per cent of the population[2]. Such a substantial increase in the proportion of older people is destined to create newer concepts of what suitable environmental sanitation should be. The conditions in environmental sanitation of the early decades of the twentieth century will doubtless be markedly improved during the closing decades of this remarkable century, one of the most energetic and fruitful in the history of the human race.

The lag phase in man's scientific development is over. He has paid a tremendous price for his ignorance in suffering, misery, squalor and death. Now that he is emerging into the sunlight of intelligent understanding; now that he has freed himself of the shackles of brute labor; now that mere survival seems more secure if we disregard the weapons of modern warfare, he will unquestionably strive for the attainment of those things that add beauty, comfort and contentment to daily living. In the attainment of this objective, the environment will be mastered to a degree hardly visualized even by our foremost dreamers today. In the attainment of the city of the future, the needs of environmental sanitation in the broadest sense of that term, will play a leading role: only then will the vision of man for the attainment of the Holy City be realized. We have come a long way since 1890 but "the light shines only on the path ahead."

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